The American Journal of Surgery

EDITED BY THURSTON SCOTT WELTON, M.D., F.A.C.S.

July 1941

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The Rationale of Suture Use

BRIEF DISCUSSIONS BASED ON REPORTS OF CURRENT RESEARCH AND CLINICAL OBSERVATION

Knot Security

THE KNOT is the weakest point in the tied suture when considered apart from the holding power of tissues.

The thread strength of both absorbable and non-absorbable suture materials is reduced by the twisting of the strand during knotting. More important still, knots become untied with greater frequency than is generally realized and this undoubtedly accounts for a certain number of suture failures.

The type of knot and the size and type of suture material affect knot security. Moreover, recent investigations have shown that, irrespective of deftness in tying sutures and ligatures, there is considerable variation in the security of the knots tied by any one individual.

Considering all factors, the triple throw knot with all loops tied square is the safest.

The square knot is next in reliability providing both throws are firmly set. This is best accomplished by relaxing tension on the strands while making the second throw. In this way the set of the first throw will not be disturbed as the second is tied.

The surgeon's knot and the knot constructed with three strands at the end of a continuous suture are least reliable. In the former, the extra twist in the first throw prevents the second from setting securely. In the latter, the extra strand unbalances the set in both throws.

In tying any knot with one hand, the throws are less uniformly set, giving less security.

Because of increased bulk and less pliability in the strands, the knot in larger sizes of sutures cannot be pulled together as snugly as in finer sizes. The knot is therefore more secure in the finer sizes.

Leaving long ends on knots is doubtful insurance against untying and leaves an unnecessary amount of suture material in the wound. This practice should therefore be discarded in favor of the methods mentioned above for obtaining knot security.

Discussions of six subjects in this series on Suture Use have been published. Reprints (including the above) and a bibliography will be sent on request.

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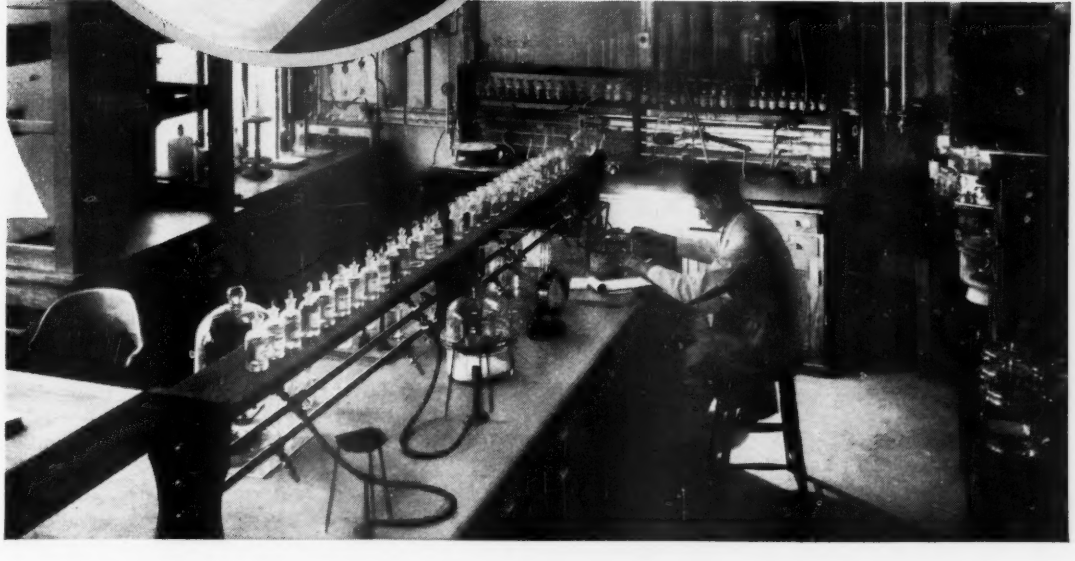

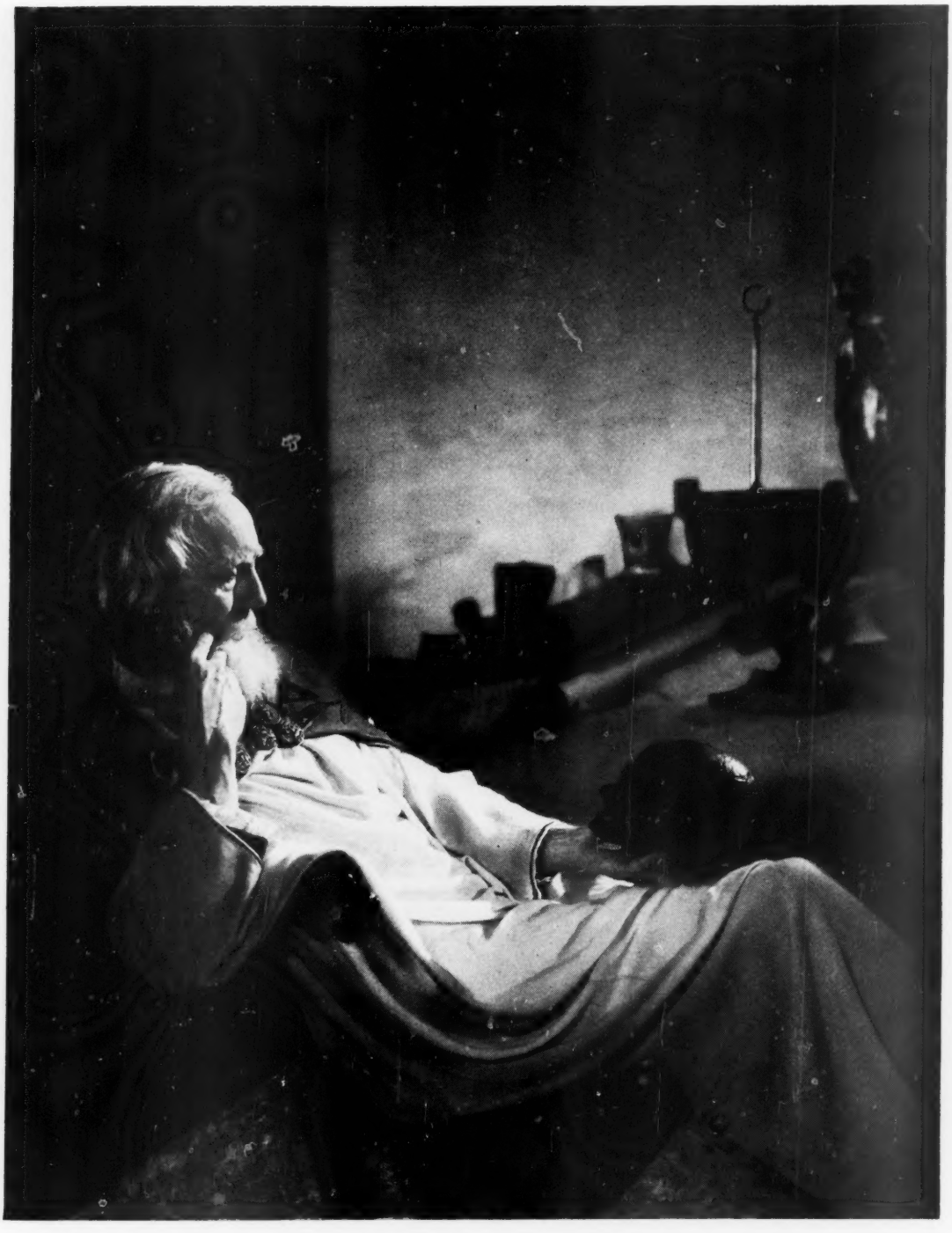

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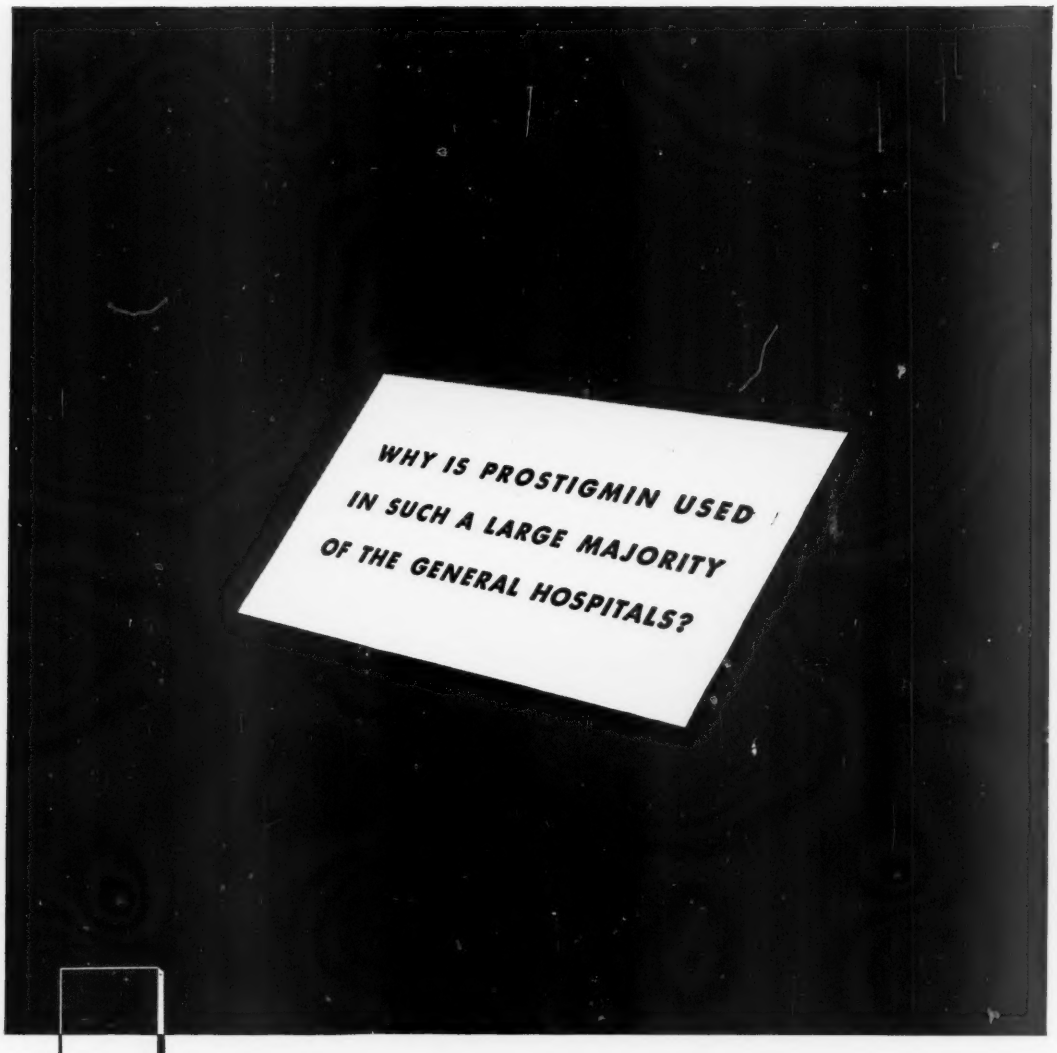

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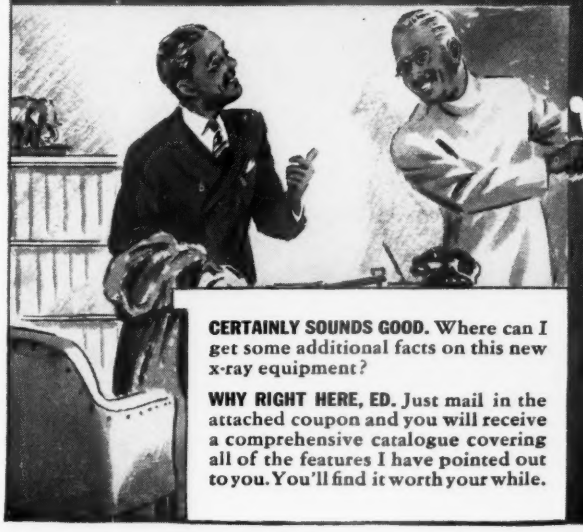

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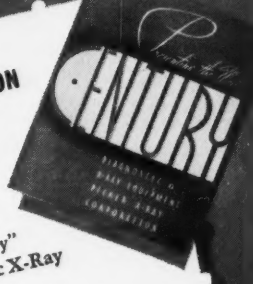

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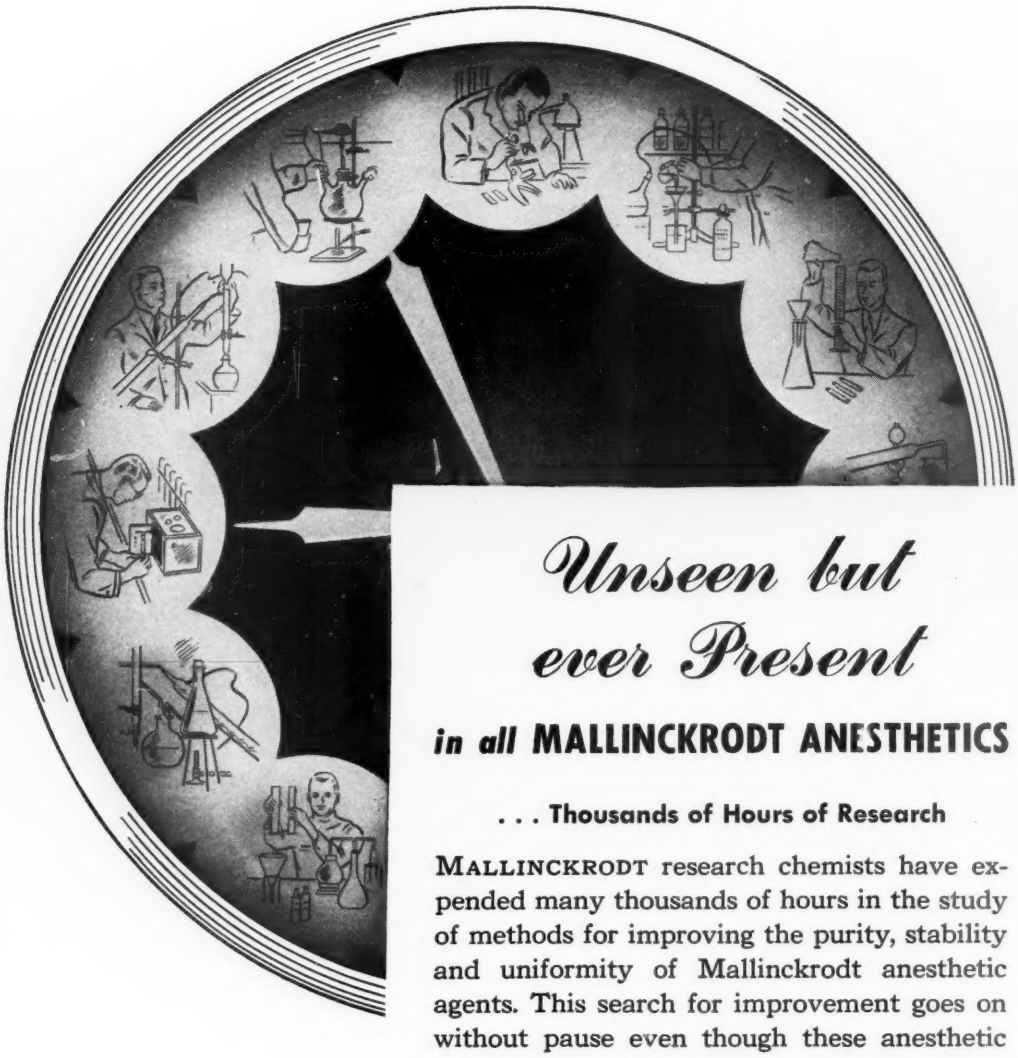

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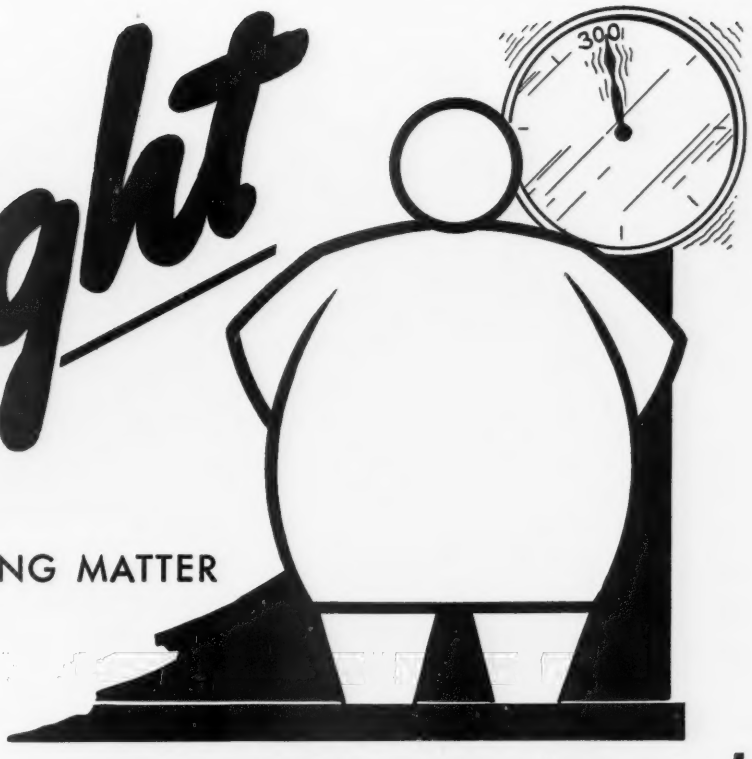

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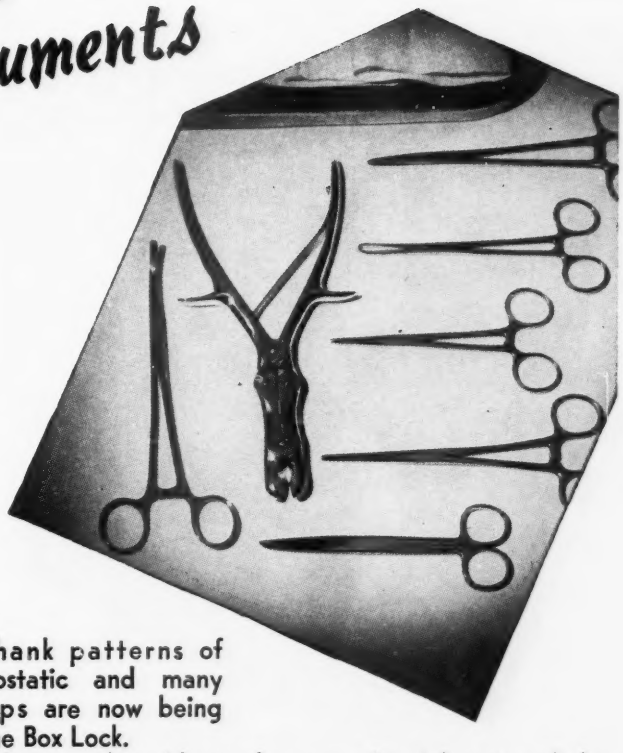

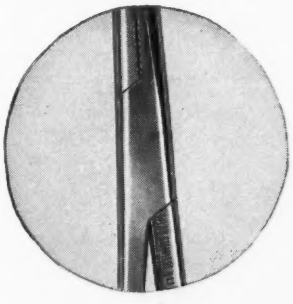

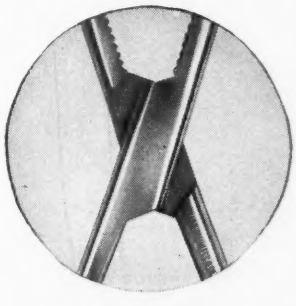

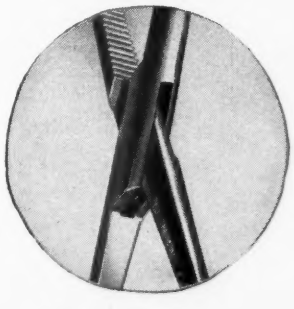

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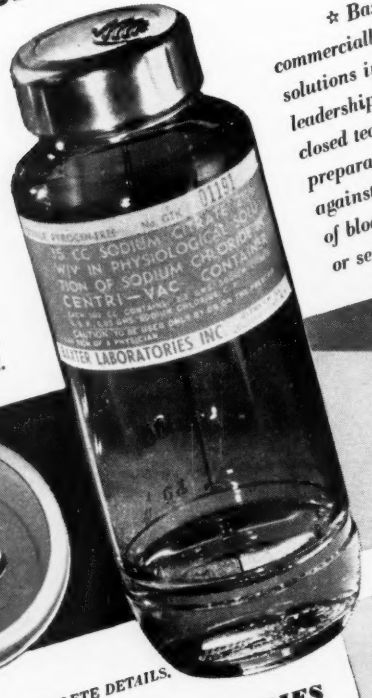

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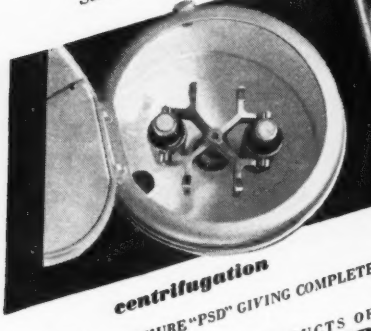

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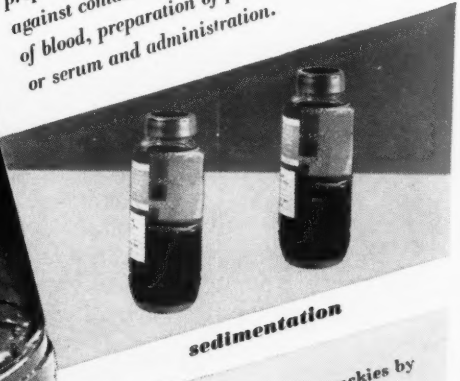

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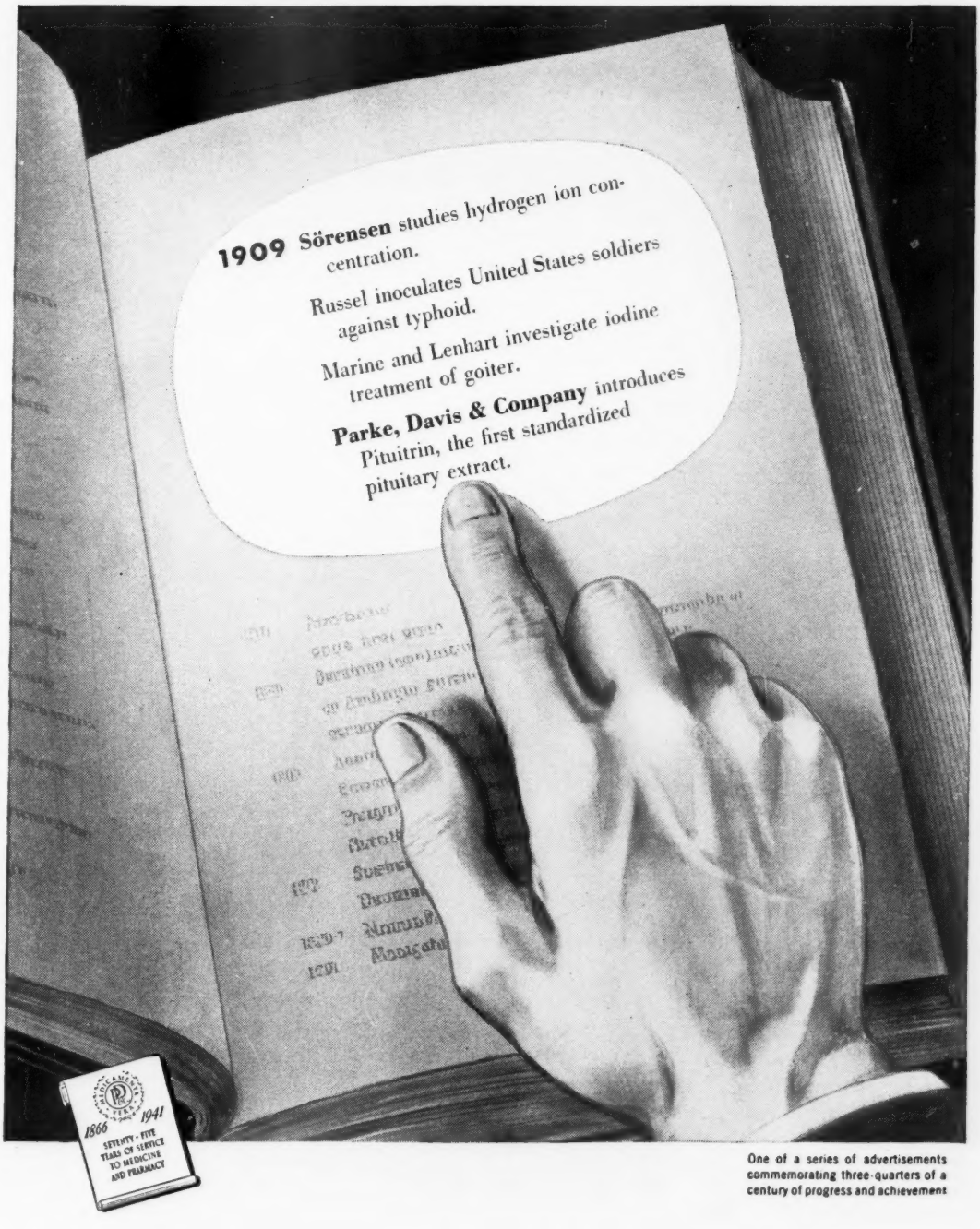
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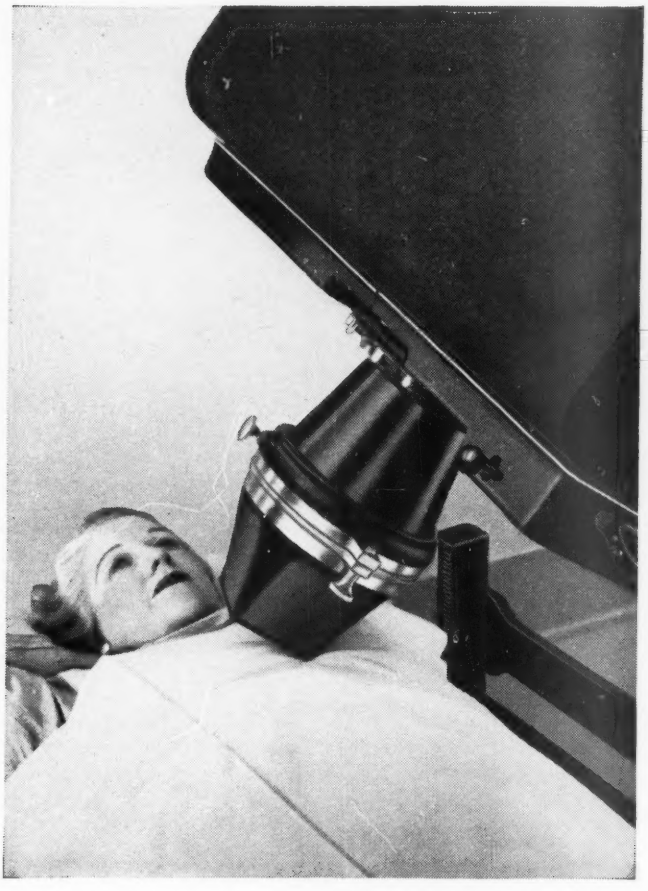

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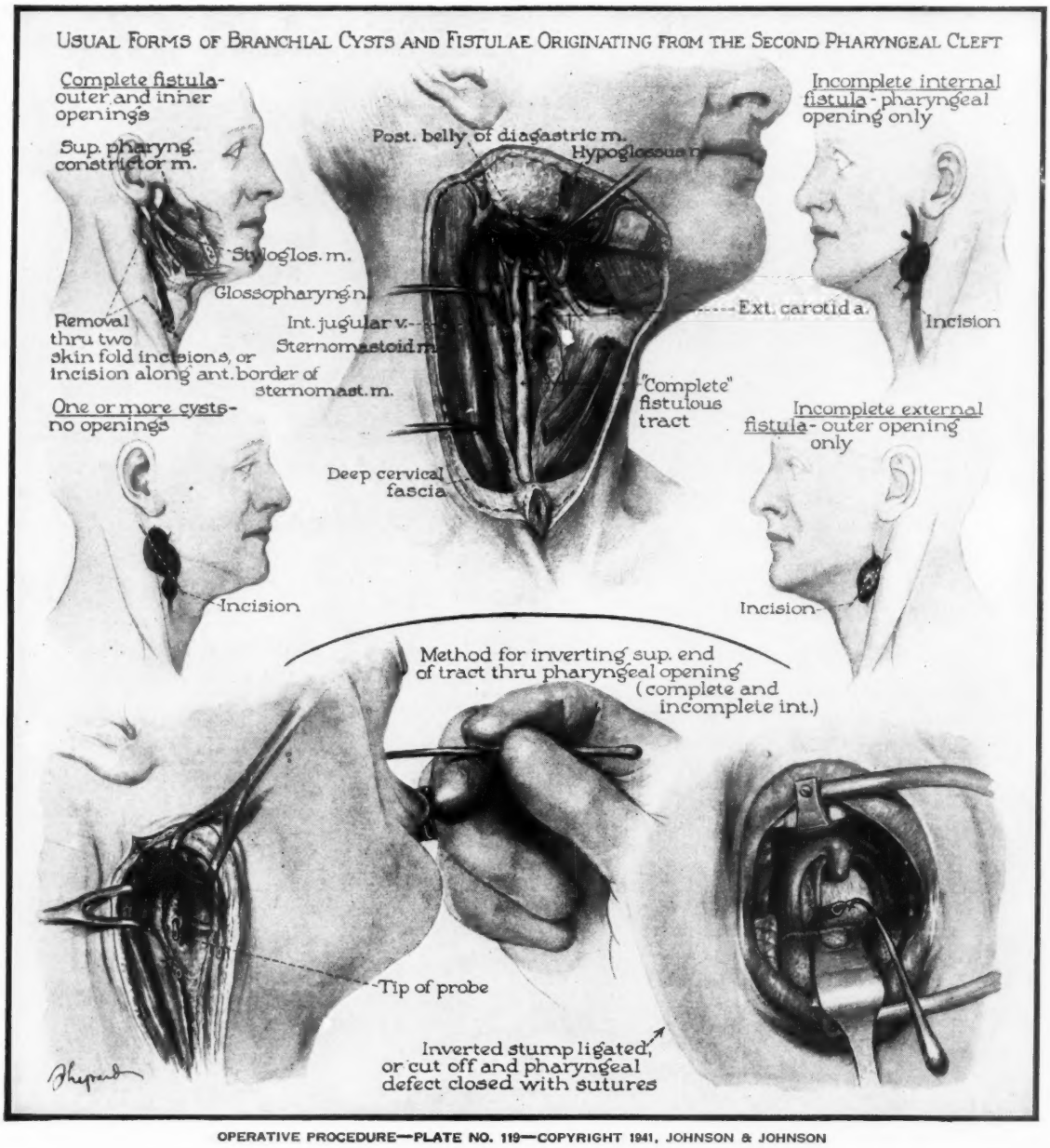
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Sup. pharyng. constrictor m.
Styloglos. m.
Glossopharyng. n.
Removal thru two skin fold incisions, or incision along ant. border of sternomast. m.
Int. jugular v.
Sternomastoid m.
One or more cysts - no openings
Incision
Post. belly of digastric m.
Hypoglossus n.
Deep cervical fascia
"Complete" fistulous tract
Incomplete internal fistula - pharyngeal opening only
Ext. carotid a.
Incision
Incomplete external fistula - outer opening only
Incision
Method for inverting sup. end of tract thru pharyngeal opening (complete and incomplete int.)
Tip of probe
Inverted stump ligated, or cut off and pharyngeal defect closed with sutures

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NEW SERIES VOL. LIII JULY, 1941 NUMBER ONE

Editorial

WORN RUBBER GOODS FOR NATIONAL DEFENSE

MARGARET E. THOMPSON, R.N., of Miami, Florida, made the following appeal, from which we quote in part:

"If you have not already begun to save and to sell your worn rubber gloves, bottle stoppers, tubing, Asepto and ear bulbs, in fact all kinds and grades of rubber goods usually discarded, it is easy to do so, and now is the time to begin, for our government needs all of the rubber it can get.

"Recently, Paul Mallon, (Miami Daily News, January 15, 1941) the newspaper columnist, stated that 300,000 tons of rubber are needed for the national defense program but to that date only 85,000 tons had been bought.

"Perhaps you heard Mr. Harvey S. Firestone, Jr., of the Firestone Tire & Rubber Company, Akron, Ohio, in a radio broadcast last fall, state that our second means of procuring rubber was to conserve that already in the United States.

"Nearly all hospitals, doctors and dentists in private practice, discard daily what to them is worthless rubber, but if saved and sold to scrap dealers would find its way back to commercial reclamation plants, hence available for national defense.

"Mr. Firestone makes the following valuable suggestions about the disposition of used hospital rubber: 'It would be my suggestion that you sell your hospital's scrap rubber, including that from sheeting, hot water bottles, rubber gloves, tubing, etc., to any scrap dealer who will give you the best price for it. In that way it will find a route to the reclaiming plants and the hospital will obtain some salvage value from it. Market prices of scrap rubber fluctuate the same as do prices of any other commodities. Further, different prices for the same grades will prevail in different communities because of differences in shipping costs that must be incurred to get the rubber to points where it can be reclaimed. Speaking generally, however, the types of scrap rubber which a hospital can accumulate will vary in price from less than a cent a pound to several cents per pound, with gloves and other "pure gum" articles commanding the higher prices. If the scrap is sorted by articles or grades of rubber, it should bring more than if sold in one bulk lot.'

"Usually all that is needed to get doctors in private practice to bring their useless rubber to the hospital, and to get hospital employees to save all worn rubber goods passing through their hands, is to explain to them the Government's need for rubber and to provide conveniently placed receptacles for 'Salvage Rubber.'

"Boxes and cartons in which supplies and equipment were shipped to the hospital make excellent storage containers at no additional cost to the hospital.

"It is surprising in how short a time a salable supply of rubber will accumulate in even a small hospital. The effort is negligible and the esprit de corps such a program stimulates is well worth it."

T. S. W.

Original Articles

THE SURGICAL CORRECTION OF MANDIBULAR PROGNATHISM

GORDON B. NEW, M.D. AND JOHN B. ERICH, M.D.
Section on Laryngology, Oral and Plastic Surgery, The Mayo Clinic
ROCHESTER, MINNESOTA

IN spite of difficult and discouraging problems which arise not infrequently in the treatment of mandibular prognathism, remarkable esthetic results are being achieved in such cases by means of various surgical procedures. Less spectacular than the cosmetic effect of these operations but of equal importance is the improvement in masticatory ability and emotional stability of the patient.

The fundamental surgical principles employed in the correction of a protruded lower jaw were established years ago. Yet, so many different procedures, based on these principles, have been advocated in the treatment of this condition that the subject is definitely, if not decidedly, confusing. We should like to present, therefore, those methods which in our experience have proved to be most satisfactory and which incur a minimal number of complications.

Mandibular prognathism has been defined as "an abnormal protrusion of the lower jaw," as "an anterior displacement of the inferior maxilla," or as "a mesial relationship of the lower to the upper dental arches." Although atavism has been suggested as a possible causative factor, heredity undoubtedly is responsible for the development of many protruded mandibles. The majority of lower jaws so deformed probably are the results of processes which disturb the normal eruption of the teeth and the subsequent growth of the mandible. Too frequently disregarded is the fact that the development, eruptions and ultimate position of the teeth in the dental arches determine the contour of the maxillary bones. As each tooth erupts, the jaws progress another step in development by expanding and changing in form to meet the physiologic requirements of support for the tooth. The conformation of the jaw bones, therefore, is continually being altered until eruption of all the permanent teeth has been completed. Any factor which disturbs the development or position of the teeth may, under favorable circumstances, initiate the occurrence of a protruded lower jaw. The causative factors which induce malposition of the teeth, and in turn, prognathism of the mandible, are inheritance, supernumerary teeth, abnormalities of the tongue, early loss of deciduous teeth, long retention of deciduous teeth, late eruption of permanent teeth, early loss of permanent teeth and improperly made dental restorations. Other general causes are rickets, syphilis and diseases of childhood which not infrequently disturb the normal physiologic processes of the growth and eruption of teeth.

If the cusps of the teeth in a protruded lower jaw interlock firmly with the cusps of the upper dental arch, the degree of protrusion of the mandible will not be augmented after the eruption of permanent teeth has been complete. However, if the

malposition of the jaws is such that the teeth occlude very poorly or not at all, anterior displacement of the mandible may continue indefinitely, later to become more pronounced.

Fig. 1. *a*, preoperative photograph of a patient with a prognathous mandible associated with an old horizontal fracture of the upper jaw which was displaced posteriorly. The deformity was corrected by bilateral resection of a segment of the body of the mandible in the bicuspid region on the left side and in the second bicuspid and first molar regions on the right. Because of the displaced upper jaw, the anterior fragment of the lower jaw was forced back to a position in which the lower anterior teeth were in labial occlusion to the upper anterior teeth. Following extraction of the patient's two upper central incisor teeth, satisfactory dental occlusion was later established by the use of an artificial, partial, upper denture; *b*, postoperative photograph with the patient's artificial upper denture in position; *c*, preoperative dental casts revealing the malrelationship of the jaws and the lack of dental occlusion; *d*, postoperative casts. Occlusion was later corrected by the insertion of the upper denture.

A rare cause of apparent protrusion of the lower jaw is an unreduced horizontal fracture of the superior maxilla which has been driven backward. When such a fracture occurs in childhood, the apparent forward extension of the mandible becomes an actual protrusion since, with the subsequent development of the teeth and surrounding bone, the unrestricted anterior displacement of the lower jaw becomes increasingly more severe.

It is well to mention that such conditions as acromegaly, which induces marked hypertrophy of the lower jaw, are not of concern herein because they are of no surgical significance.

The difficulties in a discussion of the factors which contribute to the development of mandibular prognathism are obvious, since so much uncertainty prevails. On an attempt to analyze a series of protruded mandibles, it would be discovered that they do not fit into simple causative categories because many such protrusions are not the result of a single incident but of a succession of circumstances which often are not easy to evaluate. However, from

the standpoint of treatment, the causes of mandibular prognathism are actually of very little importance. On judging the problem from a preventive point of view, however, the causative background is of the utmost significance. If the aforementioned dental factors, which have been considered to be possible causes for protrusion of the lower jaw, were recognized and corrected during childhood, no doubt many instances of mandibular prognathism could be averted.

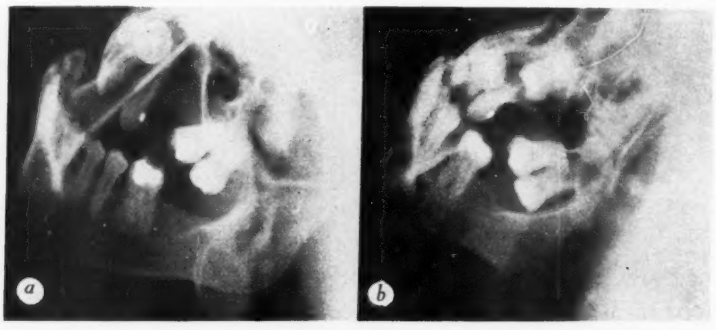

FIG. 2. Roentgenograms of the left side of the jaws of the patient shown in Figure 1; *a*, preoperative roentgenogram; *b*, postoperative roentgenogram. These roentgenograms were taken at a slightly oblique angle, resulting in the appearance of overlapping of the cut ends of the bony fragments between the lower cuspid and first molar teeth.

Objectively, considerable variation may be observed in any group of protruded mandibles. In this respect, particular reference is made to the degree of anterior displacement present, the size of the mandible itself and the position of the lower teeth in relation to the upper dental arch. All these factors are of importance in determining the course of therapy most suitable in each case. In some prognathous mandibles, the protrusion is so slight that the lower anterior teeth are situated merely in labial occlusion to the upper anterior teeth, whereas in other cases, the inferior maxilla may extend forward for a distance of 1 cm. or more beyond its normal position. Many protruded lower jaws actually are the result of bony hypertrophy or overgrowth in which the mandibular angles are sharply evident and in which the jaw is thick and bulky. Again, there are other cases in which the lower jaw is approximately of normal size but in which by some abnormal physiologic process it has slid forward; in such mandibles, the angles become markedly rounded or obtuse and not easily demonstrable. When the lower posterior teeth are tilted lingually, the mandible is expanded laterally. In all protruded lower jaws, the lower anterior teeth tend to possess a backward inclination. This type of mandibular deformity is always associated with malocclusion, although in instances of only slight anterior displacement, the lower teeth may interlock firmly with the upper dental arch and evidence a strong bite. On the other hand, in instances of marked mandibular protrusion, dental articulation may be entirely lacking, with the result that the patient experiences great difficulty in masticating food.

Occasionally, mandibular prognathism is associated with a small and narrowed upper jaw, a circumstance which increases the visible external deformity. Although of infrequent occurrence, a protruded lower jaw may exist with an "open bite," in which the lower jaw is tilted downward so that the upper and lower anterior teeth fail to meet. Finally, there are patients in whom a protrusion of the lower jaw is not real but is only apparent, being caused by traumatic posterior displacement or by congenital hypoplasia of the upper jaw; in such cases, treatment should be directed to the superior maxilla rather than to the mandible.

TREATMENT

The treatment of mandibular prognathism embodies three phases: esthetic, functional and psychologic. Any operation intended to correct this type of deformity should not only improve the facial contour and functional activities of the jaws but also should benefit the patient's emotional attitude toward his condition. As yet, no operation has been originated which is capable of producing completely satisfactory results in every case. Moreover, all that is implied in the treatment of protruded mandibles cannot be condensed within the narrow scope of a single surgical technic. Consequently, during a period of many years, numerous operative procedures have been devised in an attempt to improve the end results of treatment and to prevent the development of undesirable complications. Each procedure possesses distinct advantages and also, we may stress, definite disadvantages. In their enthusiasm for one special technic, some surgeons apparently disregard or greatly minimize the unsatisfactory features of the method. As a matter of fact, in some of these operations the adverse attributes conspicuously overshadow the alleged advantages. The technics which should be employed, of course, are matters of personal opinion and experience. The decision is a question of determining whether, in view of certain possible complications, the advantages of a certain procedure are of sufficient significance to warrant its use. In the following pages, we wish to present our views on the subject and to outline the technic which we find preferable in most instances.

The methods employed in correcting mandibular prognathism may be grouped as follows: (1) Bilateral resection of a segment of the mandible in the bicuspid or first molar regions; (2) bilateral resection of a portion of the body of the mandible near the angles; (3) osteotomy of the ascending rami above the mandibular foramina; (4) osteotomy through both necks of the mandible; (5) removal of the condyles; and (6) use of orthodontic methods.

Bilateral resection of a portion of the mandible in the bicuspid or first molar regions for the correction of mandibular prognathism has been practiced for many years. In general, we believe that this method is preferable in the majority of

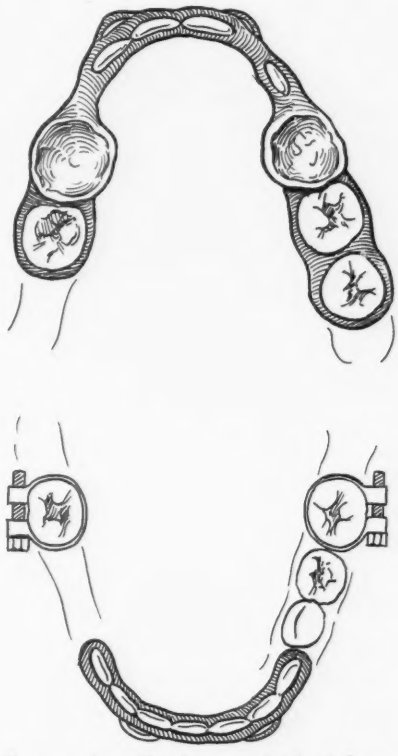

Fig. 3. An effective method of fixation of the bony fragments following surgical resection of bilateral segments of the lower jaw for mandibular prognathism. The above drawing shows the dental appliances which were used for such fixation for the patient in Figure 1. On the upper arch is seen a cast silver splint with occlusal sockets for the reception and retention of the lower first molar teeth when the jaws are closed. On the lower arch another cast silver splint surrounds the lower anterior teeth, and a molar band with its buccal sheath is attached to each lower first molar tooth. These mechanical devices are cemented to the teeth a day prior to the operation on the lower jaw. The use of the dental appliances in the immobilization of the mandibular fragments is described in Figure 4.

cases. Access to the lower jaw is gained through bilateral incisions in the skin. Following resection of the desired portions of bone, the anterior fragment is displaced backward in such a manner that not only the cut ends of the anterior and posterior fragments lie in apposition, but also, the lower anterior teeth occupy a normal relationship to the upper anterior teeth. The segments of bone may be removed in one of two ways as described by Blair and others. The first is the "closed" or "submucoperiosteal" plan in which the periosteum in the bicuspid or first molar regions is reflected away from the mandible prior to resection of the segments of bone, great care being required not to produce a perforation that will communicate with the oral cavity. In this method, if the regions in which the sections of bone are to be removed are not edentulous, the existing teeth must be extracted several months prior to the operation on the bone. The second is the "open" or "transmucoperiosteal" method in which the mandible is exposed both externally and from within the mouth, no attempt being made to elevate the periosteum. This operation we do without injury to the mandibular nerve or vessels.

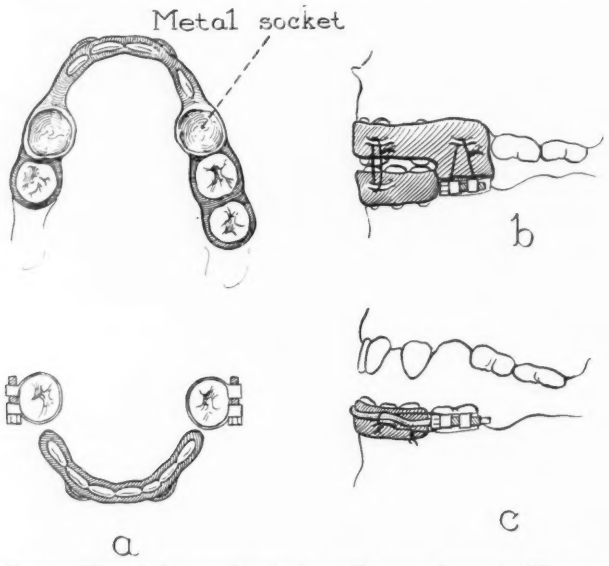

FIG. 4. Use of the mechanical appliances shown in Figure 3; *a*, relative position of the lower splint to the lower first molar teeth after the lower bicuspid teeth have been extracted and the bony segments resected; *b*, following removal of the two portions of the mandible, the anterior fragment may be forced back to the desired position and wires may be stretched from the lower casting and molar bands to the casting above. These wires firmly fix the lower jaw fragments to the upper dental arch. Not shown in the drawing is the wire stretched between the molar band and lower casting on either side; these wires maintain the cut ends of the fragments in close approximation; *c*, after four weeks of immobilization, the upper casting and intermaxillary wires are removed and are replaced by a heavy round wire arch bar; the ends of this bar are inserted into the sheaths of the two molar bands and the bar itself is securely anchored to the lower casting by wires. Such an arch bar gives adequate fixation of the bony fragments at this stage and allows the patient free mobility of his jaws.

It is the aim of the first method to eliminate infection of bone by preventing contamination of the wound by oral secretions. However, we prefer the second

method for the following reasons: (1) The sawing can be accomplished with much greater precision; (2) when operating by the closed method, the surgeon often accidentally produces a small, perhaps unnoticeable, nick or tear in the oral mucous membrane and thus inadvertently contaminates the wound; (3) with adequate drainage, we have never seen osteomyelitis develop as a result of the open method; (4) we are of the opinion that osteonecrosis is more likely to occur if the bone is stripped of its periosteum than if it is not; (5) by means of the open method, it is technically much easier to preserve the mandibular nerve and blood vessels. Many surgeons consider severance of the mandibular nerve to be of little consequence, but those of our patients who had the mandibular nerve cut complained bitterly of subsequent numbness, and in some instances, normal sensation in the lower lip never was regained entirely. Consequently, we prefer to employ a technic by means of which the continuity of the nerve is maintained. Although it may require considerable time and patience to remove a segment of the lower jaw without injuring the mandibular nerve and blood vessels, we believe that it

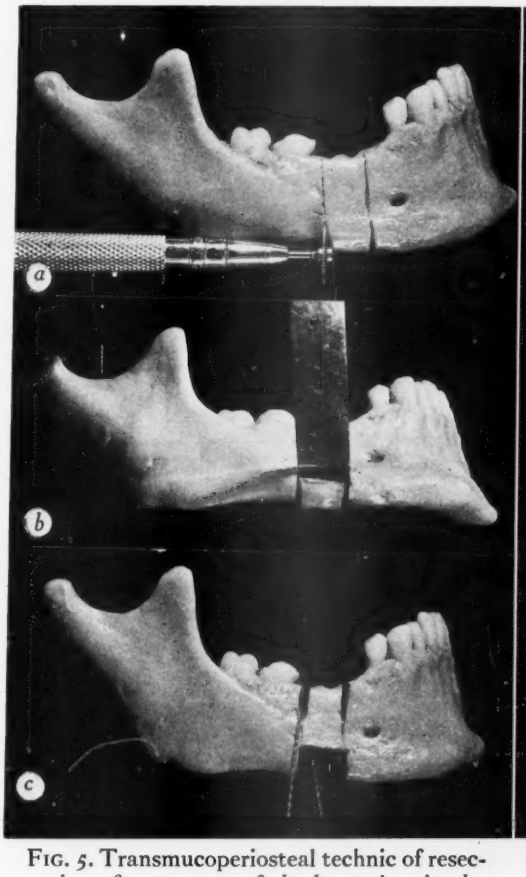

Fig. 5. Transmucoperiosteal technic of resection of a segment of the lower jaw in the second bicuspid and first molar regions without injury to the mandibular nerve and blood vessels; *a*, parallel lines indicate the segment of bone to be removed, and the motor driven circular saw makes two cuts from the lower border of the jaw up close to the level of the mandibular canal; *b*, a chisel is used to remove the intervening bone; *c*, two similar parallel cuts are made from above down close to the canal with a Gigli saw, and a chisel cuts away the bone between these two cuts.

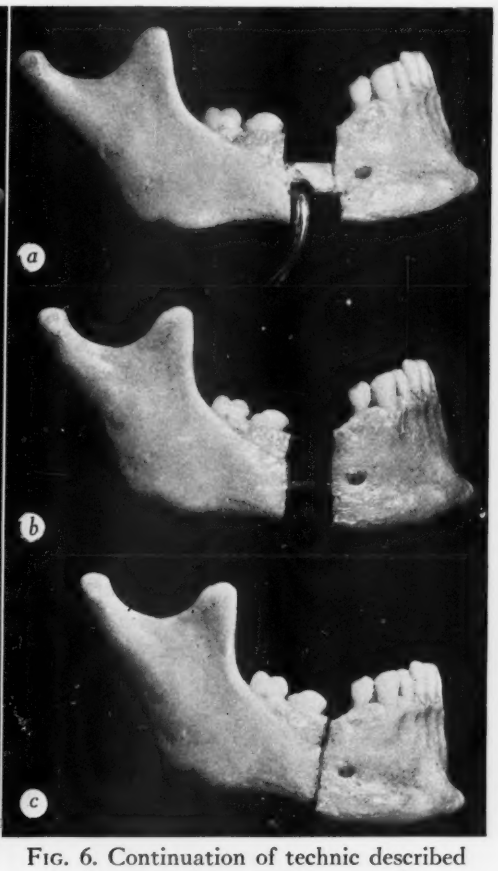

Fig. 6. Continuation of technic described in Figure 5; *a*, rongeurs are used carefully to remove the remaining portion of bone about the mandibular nerve and blood vessels; *b*, the mandibular nerve and vessels are exposed intact; *c*, the two bony fragments are placed in apposition to each other. If, by means of a curet, a small amount of cancellous bone surrounding the nerve and vessels in either fragment is removed, a cavity is created in which the nerve and vessels can rest without injury.

is not a difficult procedure and that the effort is well rewarded by the additional comfort experienced by the patient.

The advantages of bilateral resection of the body of the mandible in the bicuspid or first molar regions for mandibular prognathism may be listed as follows: (1) This method insures accuracy in cutting the bone, because the surgeon has perfect visualization of the field of operation; (2) should nonunion of the bony fragments occur following this operation, union can easily be obtained later by means of a bone graft; (3) use of this method does not result in the development of an open bite, which is a serious complication of some other procedures; (4) this method is particularly well adapted to instances of mandibular protrusion associated with an open bite. The disadvantages of this method consist of the following: (1) Infection of bone is mentioned as a complication of this method, although we have never seen osteomyelitis develop when adequate drainage was instituted; (2) residual scarring in the submaxillary regions occasionally occurs, but if conspicuous, it can be corrected by plastic procedures; (3) this method is most difficult to employ when the lower posterior teeth are absent, because these teeth offer the means of fixation for the posterior fragments, although it would be possible to immobilize the posterior fragments by inserting near the angles wires fixed to a plaster head cast; (4) this method results in a diminution of the size of the lower dental arch, which is of little consequence; and (5) this method is technically more difficult than some of the other methods.

In 1912, Harsha described a method of performing bilateral resection of a rhomboid portion of bone from the body of the mandible between the last molar tooth and the angle. The patient whom he treated by this method obtained an excellent result and the operation was performed in such a manner that both mandibular nerves were preserved intact. Although this procedure does maintain the continuity of the lower dental arch, we believe that, compared to other methods, it is entirely too difficult to warrant its general use. Furthermore, approximation and immobilization of the fragments by Harsha's plan are difficult without some means of internal fixation in the form of wires, ligatures or bone plates. Such fixation is likely to cause osteonecrosis with a disastrous end result.

In the treatment of a protruded mandible, many surgeons prefer osteotomy of the ascending rami just above the mandibular foramina. By means of this operation, the entire body of the lower jaw may be forced backward to a position that is in harmony with the superior maxilla. If healing of the cut edges of the ascending rami occurs, an excellent result may be anticipated. However, since it is not always possible to manipulate the bony fragments to the desired position, nonunion may occur if they do not lie in close approximation. Invariably, this complication leads to the condition of "open bite," which is even more serious than nonunion. Occurrence of these complications is extremely unfortunate, because they are most difficult and often impossible to rectify, and the patient is left unable to incise and masticate food. Furthermore, the condition of "open bite" sometimes gradually develops even after the fragments have healed by bony union. Although the aforementioned complications probably do not occur frequently, they are of sufficient gravity to have caused us to limit the use of this method to one group of protruded mandibles, namely, those which cannot be corrected by bilateral resection of a portion of the body of the lower jaw because no lower molar teeth are present for fixation of the posterior fragments. If the method of osteotomy through the ascending rami is to be employed, the patient should be informed preoperatively of the remote but possible complications of this procedure. We do not wish to give the impression that this method is to be condemned, because, when it is successful, it produces the finest cosmetic and functional results. We are,

however, of the opinion that this method should not be used indiscriminately.

The procedure of osteotomy through the ascending rami has the following advantages: (1) It is comparatively easy to perform from a surgical standpoint; (2) contamination of the wound by intra-oral secretions is eliminated; (3) the continuity of the lower dental arch is not disturbed; (4) little or no visible scarring is produced; and (5) the mandibular nerve and blood vessels are never injured.

We believe that osteotomy through the necks of the mandible generally does not effect as satisfactory results as do the former methods, and that such a form of osteotomy occasionally leads to the condition of "open bite." However, Pettit and Walrath reported good results achieved by their so-called low back angle.

Dufourmental advocated the removal of both condyles as a means of correcting a protruded lower jaw. However, this method has limited possibilities because it cannot be employed in cases of severe protrusion. Surgeons who have tried this method report that in many cases the condition of "open bite" subsequently develops.

In summarizing the treatment of all types of prognathous mandibles, we wish to clarify our opinions on the subject. As a preliminary measure, considerable deliberation is required to determine the course of treatment best suited to each patient. Roentgenograms of the jaws and teeth, photographs and plaster dental study models are indispensable. The method of therapeutic approach, naturally, differs sharply in children from that used for adult persons. For children and youths, the treatment should be limited to orthodontic procedures, by means of which much can be accomplished. We strongly urge the prompt recognition of early instances of mandibular protrusion as evidenced by malrelationship of the jaws or teeth in children. These young patients should receive expert orthodontic therapy without delay in an effort to prevent the deformity from increasing in severity during the growing and developmental period of the mandible. Not until the individual who has a protruded lower jaw has reached early adult life should surgical methods of correction be considered. When the degree of protrusion is so slight that the lower anterior teeth merely lie in labial occlusion to the upper anterior teeth, corrective surgical operations are contraindicated. If the condition in such cases cannot be corrected by the orthodontist, we prefer not to attempt treatment at all. We believe that all instances of marked mandibular prognathism in adult patients should be corrected by bilateral resection of a segment of the body of the mandible, provided that one or more lower molar teeth are present on each side for fixation of the two posterior fragments. There can be but little argument to our assertion that this method is the most satisfactory way of dealing with protruded lower jaws associated with "open bite." If, in instances of mandibular protrusion, the upper jaw is congenitally small or is displaced posteriorly, we never attempt to force the mandible back to a point at which the lower anterior teeth are situated in lingual occlusion to the upper anterior teeth. On the contrary, we surgically move the lower jaw backward merely to a position in keeping with normal facial contours; subsequently, the upper dental arch is brought forward into natural articulation with the lower teeth by orthodontic methods whenever feasible or, more commonly, by the use of an artificial, partial denture. (Figs. 1*a*, *b*, *c* and *d*, and 2*a* and *b*.) For patients who have lost their molar teeth and who are particularly desirous of having their protruded mandible corrected, the method which utilizes osteotomy through the ascending rami is indicated. Absolute immobilization of the lower jaw is accomplished in such cases by the use of a cast silver dental splint which is securely cemented to the remaining lower teeth and firmly wired to the upper dental arch. When necessary, increased stability can be obtained by extending the silver casting back over the edentulous alveolar

ridge in both lower molar regions, and by fixing these phalanges to the lower jaw by circumferential wires. Following performance of surgical procedures for the correction of mandibular prognathism, the occlusion of the teeth should receive attention in an attempt to improve the masticatory function of the jaws; such attention may consist in grinding down high dental cusps which interfere with the articulation of the teeth, of the possible utilization of orthodontic measures, or of the use of artificial partial dentures.

As previously expressed, the method of bilateral resection of a segment of the body of the mandible is the one which we prefer to use for the correction of the majority of protruded lower jaws. In performing this operation, the technical details which we have found expedient to employ are as follows: First, impressions of the upper and lower dental arches are secured. Next, from these may be prepared two sets of plaster models; one for purposes of study and the other for use by the dentist in constructing cast silver dental splints; such splints in our experience have proved to be excellent agents for postoperative immobilization of the jaws.

Invaluable and essential are well made study models. Only from such casts can there be effected a satisfactory determination of the size of the segments of bone to be removed. The distance from the labial surface of the lower anterior teeth to the lingual aspect of the incisal edge of the lower anterior teeth to the lingual aspect of the incisal edge of the upper front teeth represents the degree of mandibular protrusion present, unless an associated posterior displacement of the superior maxilla is present. The width of the resected portion of bone on either side of the mandible should equal the degree of anterior displacement of the lower jaw. By examination of the study models, the surgeon can ascertain which teeth necessarily must be extracted and, in turn, just what portions of bone should be resected. Wherever possible, we prefer to sacrifice the second bicuspid and first molar teeth, because in removing a segment of bone in this region, the surgeon can keep the operative field at a safe distance from the mental foramen and thus avoid possible injury to the emerging mental nerve and vessels. However, when on either side the second and third molar teeth are absent, it is necessary to retain the first molar tooth for fixation of the posterior fragment, and consequently, the segment of bone must be resected in the first and second bicuspid regions.

In a protruded mandible associated with "open bite," the removal of a properly shaped section of bone from each horizontal ramus will correct both deformities simultaneously. Without study models, it would be most difficult to fashion patterns for guidance of the surgeon in resecting segments of bone of appropriate size and contour. Schultz has prepared an admirable diagram by means of which a precise, mathematical determination of such a pattern can be made for each patient. The reader should consult Schultz' paper on this subject.

Much of the success of any surgical operation for the correction of mandibular protrusion is dependent on the effectiveness of the appliances used in immobilization of the bony fragments. Too much consideration of this subject can never be given preoperatively. As far as the operation under discussion is concerned, it may be asserted that the degree of ultimate success or failure of this procedure is proportionate to the ability of the immobilizing agents to maintain the fragments in the desired position until bony union is complete. We rely for immobilization entirely on various forms of dental retention. In general, we prefer cast silver splints and orthodontic molar bands which are cemented to the teeth rather than the conventional wires twisted about the necks of the teeth. The former appliances cannot be displaced and possess the rigidity and stability often lacking in the latter type of dental wiring.

To facilitate a description of the method of dental fixation which we advocate, consider a case of mandibular protrusion in which there is a full complement of upper and lower teeth. Prior to the operation, the dentist obtains the plaster models of the jaws, and cuts away the lower second bicuspid and first molar teeth on each side (the regions in which the segments of bone are to be removed). After the width of the portions of bone to be removed has been ascertained, the lower model is cut into three pieces similar to the fragments of bone which will be formed by the operation. While the anterior plaster fragment is forced back to the desired position, the cut ends of the two posterior fragments are rotated slightly in ward. The three plaster fragments and the upper plaster model are then mounted on a dental articulator in the same relationship as will exist in the mouth after the operation. Since the mandible flares outward from the symphysis to the angles, it is of the utmost importance to rotate the two posterior plaster fragments slightly inward; otherwise, the anterior fragment, when displaced backward, will become telescoped between the two posterior plaster segments. By carrying out the aforementioned treatment to the plaster models, the dentist now has the plaster teeth in the exact position required of the patient's teeth following the operation.

By means of the plaster casts previously described, which are cut and mounted on an articulator, it is possible for the dentist to construct a cast silver splint (Fig. 3), which may be cemented to the upper dental arch. This splint hugs the labial, buccal and lingual surfaces of the upper teeth, spans some of the interproximal spaces, but does not cover the incisal edges or occlusal tooth surfaces. This splint possesses two cup-shaped, occlusal depressions of sockets for the reception and retention of the two lower second molar teeth. A similar type of silver casting is next made to fit the teeth of the lower anterior fragment (Fig. 3). Both upper and lower castings possess hooks for subsequent intermaxillary wiring. The day before the operation, these castings are cemented in their proper positions. Also, a molar band having a buccal sheath is screwed and cemented to each lower second molar tooth. Following the surgical procedure, heavy intermaxillary wires are stretched between the hooks of the two castings and between the buccal sheaths of the molar bands and the upper casting (Fig. 4*a* and *b*); simultaneously, the lower second molar teeth are seated securely in the cup-shaped depressions above. The round wire arch bar in Figure 4*c* replaces the intermaxillary wires and upper dental casting at a later time, as will be described. These wires firmly bind the upper and lower jaws together. Other wires stretched from the lower casting to the molar bands retain the lower jaw fragments in close approximation.

In resecting bilateral segments of the body of the mandible (Figs. 5*a*, *b* and *c*, and 6*a*, *b* and *c*) the patient is anesthetized preferably with nitrous oxide gas and ether by the intratracheal method. It is necessary first to extract all teeth which are situated in the two portions of bone which it is proposed to remove. If the second or third molar teeth are present, the second bicuspid and first molar teeth on either side must be sacrificed. Following such preliminary measures, an incision in the skin 6 or 7 cm. in length is made in one or the other submaxillary region. The surgeon works through this incision, and the entire circumference of the mandible in the bicuspid and first molar regions is exposed by blunt dissection. The wound, of course, communicates with the oral cavity. By means of an indelible pencil, two parallel lines are drawn on the external surface of the mandible in the second bicuspid and first molar regions. The distance between these two lines represents the width of the segment of bone to be resected. A motor driven circular saw is employed and a cut is made along each of these pencil lines from the lower border of the mandible upward almost to the approximate level of the mandibular canal; this saw should be used

with considerable caution and kept at a safe distance below the mandibular nerve and vessels. A chisel is placed between the upper extremities of the two saw cuts, and by firm tapping with a mallet, the intervening portion of bone is removed. Next, two similar cuts along the pencil lines from the alveolar ridge down close to the mandibular canal are produced by a Gigli saw, and the interposed bone is detached by means of a chisel. With only a small amount of bone remaining about the nerve and vessels, careful use of a rongeur will easily expose these structures intact. Finally, with the aid of a curet, some of the cancellous bone surrounding the nerve and vessels in either fragment is removed; a cavity is thus created in which the exposed portions of the nerve and vessels can rest without injury when the anterior and posterior fragments are brought into apposition.

On completion of the foregoing technical details, an identical procedure is carried out on the opposite side of the lower jaw. A Penrose drain is inserted from within the mouth into the incision on either side; these drains emerge externally through the incisions in the skin. As a final step in the operation, the soft tissues overlying the bone are approximated and the incisions in the skin are carefully sutured. No attempt is made at this time to immobilize the fragments; fixation is postponed until the succeeding day, when the patient is not under the influence of anesthesia and when he is free of nausea.

On the first postoperative day, the patient is returned to the operating room, and his jaws are thoroughly immobilized as has been previously described. Feedings are carried on through a Rehfuss stomach tube. About one week later the Penrose drains are removed. At the end of another three weeks, at which time some bony union of the fragments should be evident, we usually dispense with the intermaxillary wires and upper dental casting. These appliances are replaced by a round wire arch bar adapted to the lower dental arch (Fig. 4*c*); the ends of this bar are inserted into the sheaths of the two lower molar bands and the bar itself is securely anchored to the lower casting by wires. At this stage of the patient's convalescence, such an arch bar gives adequate fixation of the bony fragments and allows the patient free mobility of his jaws. In general, we are in favor of leaving this appliance in position for another four or five weeks, because it is of little inconvenience to the patient and gives support to the newly formed callus. On removal of all intra-oral mechanical devices, dental occlusion is established by grinding down the interfering cusps of teeth. For younger individuals, orthodontic measures are valuable aids in producing firm articulation of the teeth. If noticeable residual scarring in the submaxillary regions occurs, the scar tissue is excised several months later.

SUMMARY

1. The causes of and objective findings in mandibular prognathism have been presented.

2. The relative values of various corrective procedures for this type of mandibular deformity have been discussed.

3. A method consisting of bilateral resection of a segment of the body of the mandible, for mandibular prognathism, has been described. In this procedure, the segment of bone on either side is removed without injury to the mandibular nerve and vessels.

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OSTEOMYELITIS OF THE SPINE TREATED WITH FUSION BY BONE GRAFT

B. KOVEN, M.D., F.A.C.S.
Attending Orthopedic Surgeon,
Jewish and Beth-El Hospitals

AND

M. T. KOVEN, M.D., F.A.C.S.
Associate Attending Orthopedic Surgeon,
Jewish and Beth-El Hospitals

BROOKLYN, NEW YORK

UP to very recent times the opinion regarding osteomyelitis of the spine was that it was a relatively uncommon disease. This was primarily due to the scarcity of reports in English literature. Recently, there has been an increasing number of cases reported. Especially to be noted is the analysis and discussion of 102 cases by Kulowski.[1] This author particularly stresses that the ratio of tuberculous spondylitis to pyogenic osteomyelitis has been but two to one since interest has been aroused at the Steindler Clinic in this affection. In general, it appears to be the concensus of opinion that when found it is a very serious disease with a greater mortality than osteomyelitis in other bones.

Our study was started prior to the publication of Kulowski's analysis. In the survey of our own statistics for the past ten years we find records of twelve cases of pyogenic osteomyelitis of the spine. Three of those affected the arches and processes; in one case, both the body and the processes were involved; eight cases affected the body alone. This proportion differs somewhat with the general average as quoted by Steindler,[3] who finds in a series of collected cases that 58 per cent showed involvement of the arches and processes, and 44 per cent of the bodies alone. Our age limit is somewhat higher than the general average. The youngest was a boy of fourteen with a multiple metastatic bone involvement, including the body of the first lumbar vertebra. Then came patients ranging in age from twenty to fifty-six. The majority of cases was found in those of the third decade. It was very interesting that our oldest patient, the only female, age fifty-six, presented a similar history, clinical course and *x*-ray findings as that in Case IV. Refusing operation, she was treated conservatively by means of a Bradford frame for a period of four months and then allowed to go about with the aid of a brace. This patient is still alive three years after hospitalization, and she frequently consults us because of pain in the back. Her latest *x*-ray examination shows evidence of marked intervertebral joint narrowing and osteo-arthritic changes but not complete fusion. She cannot carry on without her brace. The prognosis in our entire series shows three fatalities. Two deaths occurred in the cases affecting the processes alone, one death in a body involvement. All of these deaths were the result of gradual sepsis following months after the diagnosis was made and surgical procedure instituted. In contrast to other statistics, it is to be noted that seven cases in which the bodies were involved have survived. Two of these patients were treated by transversectomy and drainage. One was treated conservatively, as mentioned above, and the five last, whose case histories are appended, were treated by spinal fusion.

From the literature we find that the Staphylococcus aureus is the most frequent exciting agent. In a small percentage of cases the Staphylococcus albus and exceptionally the streptococcus are the invading organisms. Since no attempt was made to reach the spinal focus, we cannot say what organisms were present in our cases, except for the indirect evidence of blood cultures or cultures from other foci. In Case I, a Staphylococcus aureus was isolated in the preceding operation for osteomyelitis of

clavicle. In Case IV, Staphylococcus aureus bacteremia was present. Blood cultures in the other cases were sterile. Pre-existing histories of other infections are found in all the cited cases. Thus, the history of pneumonia and severe toxemia was elicited in Case I, while in Case III, one notes an acute onset of the spinal symptomatology following operation for appendicitis. The element of direct trauma plays an appreciable rôle in only one case, Case V, in which the onset of symptoms starts with a fall on the buttocks.

Just as in osteomyelitis of other bones, pyogenic infection of the vertebra comes from two sources, i.e., by direct extension or, more frequently, by the hemotogenous route with ensuing thrombo-arteritis or capillary thrombosis. This process results in the vertebra, either in (1) a subperiosteal affection, (2) an epiphyseal separation, (3) a rarifying osteitis, or (4) a completely destructive type. Because of the essential anatomical and vascular conditions as described below, thrombo-embolic lesions in the vertebra are much less frequent in comparison with other bones. When they do occur, the destructive changes produced are limited in their extent. Sometimes only the surface of the vertebra is attacked as in Case IV. At other times, there is a rapid invasion of the spongy substance, which may stop at some stage or progress until the entire body becomes infiltrated with pus and succumbs to necrosis. This is found in the other three cases in varying degrees. Due to the character of the anastomotic circulation, the formation of sequestræ is not constant but abscess formation is very common. In Case IV, *x*-ray studies beginning with the eighth day after onset of symptoms and repeated observation, show in the fourth week a pathological lesion beginning with a narrowing of the intervertebral disc and rapidly followed by signs of marginal bone necrosis. This bears out the observation of Compere and Garrison[2] that the intervertebral discs are less able to survive the attack of pyogenic disease than in tuberculosis.

The topics of symptomatology and diagnosis are so closely interwoven that they lend themselves readily to simultaneous discussion. As they apply to osteomyelitis of spine, the general symptoms are those of an acutely ill individual, with intense pain in the back, chills, high temperature and signs of various degrees of intoxication. The additional symptomatology is dependent upon the close relationship between the vertebral column to the spinal cord and also to neighboring cavities and viscera. Local symptoms are pain, rigidity of back, severe localized tenderness, both superficial and deep, and painful motion. These symptoms differ also in their degree and intensity according to the stage of the disease as one finds in osteomyelitis of other bones. Grouping of osteomyelitis in general is known to all and does not bear repetition. Diagnostically, these cases often resemble Pott's Disease. In spinal involvements, secondary to demonstrable infectious process in the soft tissues and other skeletal parts, the diagnosis is more readily made. In their absence, especially in the so-called subacute types of osteomyelitis of the spine the differential diagnosis is somewhat more complicated. In this latter type, the clinical picture may be said to resemble a condensed epitome of Pott's disease without deformity. The tendency to deformity or gibbus formation due to collapse of the involved vertebral bodies is much greater in tuberculosis. The explanation given is that in osteomyelitis, the acuteness and severity of the condition quickly prostrates the patient and keeps him on his back. In pyogenic osteomyelitis, both in general types and also those affecting the spine, the cases that present an extensive and massive distribution usually come to a fatal end much sooner. The pus formation or abscess occurs much more rapidly in osteomyelitis. With osteomyelitis we frequently find evidence of an accompanying septicemia and its various manifestations. A very valuable adjunct in making a differential diagnosis is the *x*-ray findings. In studying these, we must again repeat that

acute osteomyelitis of the spine passes through the same stages as osteomyelitis of long bones. These stages are influenced by localization and therapeutic factors. In the presence of pyogenic organisms, one invariably finds roentgenologic evidence of degeneration and proliferation at the same time. Kulowski[1] stresses that the most characteristic feature of pyogenic osteomyelitis is the presence of a reactive new bone formation characterized by spike-like projections from the margins of the affected vertebra. This so-called parrot's beak was especially noted in Case v. (Fig. 21.) Telescoping is more frequent in tuberculosis because breaking down of the bodies occurs more extensively in this condition. By contrast with tubercular spondylitis there is a rapid and early involvement of the intervertebral disks in pyogenic infections of the vertebrae.

The above mentioned factors regarding etiology, pathogenesis, symptoms and diagnosis are only briefly mentioned. One can find a more complete description of these phases of the disease in the splendid review by Kulowksi. Our attempt has been mainly to emphasize these only as they pertain to the main object of our presentation, i.e., the use of the spinal graft for fusion in this disease.

In the review of the reported cases one is impressed with two outstanding and very important facts. First to be noted is the general failure in making a prompt and early diagnosis. Such patients are frequently treated for rheumatism, arthritis, meningitis, pneumonia, typhoid or some other acute febrile condition for weeks before the true condition is realized. The primary lesion is often overlooked or subordinated to the more extensive secondary purulent infiltrations in the adjacent vital organs or body cavities because of the peculiar anatomical location of the disease. Second, the most striking feature is the employment of a surgical procedure which does not entirely concur with past and present day teaching that all suppurative areas require evacuation and drainage.

In 1930, we were confronted with a problem case. (Case 1.) We had a very sick patient whose general and local condition was gradually getting worse. The inaccessability of the abscess cavity which appeared to fill a good part of the posterior mediastinal space made the usual procedure of costotransversectomy a very hazardous therapeutic approach. The general condition of the patient did not warrant multiple rib resections. It was decided for reasons later mentioned that there would be much less shock to a spinal fusion, especially since fixation by body cast did appear to relieve his pain. The dramatic suddenness of the improvement and the marked decrease in the mobility had enthused us subsequently to employ this method in four other cases.

In the Iowa series, spinal fusion was performed under the mistaken diagnosis of tuberculosis. Kulowski deems it an unnecessary procedure in view of the tendency in this case to spontaneous fusion. In our series we find various types of pathological involvements. They were not especially selected cases. Despite application of conservative fixation treatment prior to operation the tendency was progression of the destruction rather than spontaneous fusion. Four of the five cases had prolonged bed stay and fixation applied; despite all that, repeated *x*-ray study showed definite progressive destruction.

RATIONALITY OF THE GRAFT FUSION

In order to appreciate the application of the principles of bone graft fusion in this affection it is necessary at this time to review the essential anatomic factors. Special stress is placed on the vascularity of these bones because we find that it plays a very important rôle in the process of regeneration. The anatomic factors that need be elaborated upon are, (1) the character of the bone, (2) its arterial blood supply, and (3) its venous drainage.

1. *Character of the Bone.* According to Callander,[4] "Embryologically each vertebra is developed through three primary

centers of ossification, one for the body and one for each vertebral arch. The two halves of the neural arch unite posteriorly in the first year. Five secondary centers appear at puberty and the epiphysis they form add upper and lower plates or disks to the bodies and tips to the spinous and transverse processes. These epiphyses unite about the twentieth to the twenty-fifth year." After complete ossification there exists a definite anatomical and architectural continuity of the cancellous structure of the body and the posterior process of the vertebra. This structural continuity is reflected in the horizontal and vertical trabecular systems. Absence of circumferential cartilage plate and lack of a definite subchondral layer of compact bone, as seen in normal joints, explains the rapid extension of the primary pathological processes into the contiguous disk and vertebral body. It is worth noting that the structure of the periosteum of the vertebra differs from most other bones; there is no true membrane. Rather is there an intimate adherence of periosteum to bone, the result of the innumerable penetrating fibers. This is stressed because the intimate closeness of periosteum to cortex is a factor in supplying an increased blood supply to the bone itself.

2. *Arterial Supply.* A complete description of the circulation has been given in a recent paper by Wagner and Pendergrass,[5] and the following is freely quoted, "From the abdominal aorta lumbar arteries and branches pass posteriorly, penetrating the anterior muscle group. The dorsal branches (Rami Dorsalis) arise and continue posteriorly in the horizontal plane on either side of the vertebral body, just above midline. Arteries lie in direct contact with a portion of the anterior and entire lateral wall of the vertebral body. From the medial surface of the Rami Dorsalis as they lie in contact with the vertebral body, arise branches which penetrate directly into the bone. These vary in number, but there are commonly present one main antero-lateral and a smaller lateral branch on either side. These arteries may be followed well into the middle of the vertebral body before they divide and lose their identity. In the region of the intervertebral foramen, the Rami Dorsalis divides into a spinal branch (Ramus Spinalis) and a muscular branch, which supply the muscles and the skin of the back. The Ramus Spinalis passes through the spinal foramen into the spinal canal to anastomose with its fellows and contribute to the anterior and posterior spinal arteries. From each of the anterior spinal arteries, a medial branch arises and passes medially along the posterior wall of the vertebral body. These two branches penetrate the vertebral body in the midline, at a point just about the exit of the veins. These penetrating posterior arteries may be followed well into the central substance of the vertebral body before they divide. Small pairs of nutrient vessels penetrate the posterior vertebral body wall at points just above and below the level of those just described. These latter arise either directly or indirectly from the anterior spinal arteries or their medial branches. From the size of the arteries to the vertebral bodies it can be inferred that the volume flow of blood is relatively small."

3. *Venous Drainage.* The vertebral bodies are drained by an internal system of comparatively large thin-walled channels, spaces and tracts (venous sinusoids). These sinusoids ramify throughout the greater portion of the body and communicate through small openings on the front and side of the bodies with the anterior external and anterior internal vertebral plexuses. As life advances these sinusoids become greatly enlarged. These sinusoids are lined in their central portion with a single layer of endothelial cells, and in their distant bays, lie histiocytic cells. Immediately beneath the lining cells and in the subjacent connective tissue lie numerous macrophages, the fixed wandering cells of Maximow, of high phagocytic powers, and respond rapidly by hyperplasis and the elaboration of defense bodies under the

influence of an irritant. They also contain within their lumen hematopoietic tissue and normal circulatory blood elements. Because of the sluggish movements of the blood stream in these sinuses they act as places both for lodgment or metastases of pyogenic organisms and also for their destruction and removal.

With the above anatomical picture we are now ready to correlate the operative procedures and postoperative follow-up and also to compare them with other methods of therapeutic attacks. In the explanation of the clinical application the following factors lend themselves for special discussion: (1) operative procedure, (2) lack of postoperative reaction, (3) rapid convalescence and markedly diminished time of disability, (4) early bony ankylosis and other regenerative processes and (5) the fate of the abscess.

1. *Operative Procedure.* In all our cases we employed an autogenous tibial graft for spinal fusion according to the technic of Dr. F. H. Albee.[6] The technic of the operation does not require any repetition as it is universally known. The purposes of the operation are two-fold: first, to immobilize the affected parts, and second, the use of a living graft to act as a stimulant to the osteogenetic forces. The principle of immobilization for inflamed and injured parts, as first promulgated by Hilton,[7] and Thomas,[8] has been within recent years greatly popularized in the treatment of osteomyelitis. Orr[9] aptly states, "Immobilization means first, the replacement as nearly as possible of injury parts in correct anatomic relationship, and second, the maintenance of immobilization in proper relationship until healing occurs." Whether the injury comes from a direct or an indirect traumatic force, or from the presence of an infective agent, the resultant pathology varies only in the degree of the insult. The principles of immobilization hold true both in injury and infection. Nature in its mechanism of taking care of injury or infection asserts itself by producing an attempt at fixation by muscular splintage or spasm, and limitation of function. As demonstrated in the anatomical discussions of the spine, it is composed of numerous mobile segments, whose action for the most part is that of leverage. Measures must be instituted to limit this action which not only is influenced by trunk motion but also by the motions accomplished in respiration and involuntary actions of the abdominal muscles. It is true that there are other means of fixation besides spinal fusion and these we tried before resorting to fusion. In Case I, the application of a properly applied high plaster jacket afforded local symptomatic relief. The patient's general and local condition, however, grew progressively worse. He continued to run a temperature accompanied by profuse sweating; there was increased bone destruction until the time of operation. In Cases II and IV, one notes that a Bradford frame was used for periods of two and one months, respectively, but this did not retard the progression of symptoms and local signs until the time of operation. In Case V, the patient was in a cast six weeks prior to admission. Another body jacket was applied and worn for ten weeks, followed by a Knight spinal brace and this was worn for two months. During all this time despite fixation the clinical and *x*-ray picture showed progression of the local and general symptoms. Today, nobody doubts the fact that operative fusion furnishes a form of immobilization which is vastly superior to external splinting.

2. *Lack of Postoperative Reaction.* Patients suffering from pyogenic osteomyelitis of the spine are very sick individuals. Any operative procedure must be accompanied by as little trauma as possible. To avoid postoperative complications, the time factor is of great importance. These are the most important reasons for our choice of the Albee tibial graft fusion operation. With this form of surgical fusion, one is much further afield from the seat of the pathology, and hence, one can escape the danger of infection of the stabilizing agent and prevent future sinus formation. Here

let us interpose the thought that in cases in which the involvement is primarily in the processes, surgical fusion would be contraindicated. The trauma is considerably less than in any other type of fusion operation; the danger of the anesthetic is lessened by the decreased time of the operation. All of these patients were on the operating table no longer than thirty minutes. Anterior and posterior plaster shells were prepared previous to day of operation. These operations are performed by two teams, one, preparing the graft bed in the spine, the other, preparing the graft.

3. *Convalescence.* All the cited cases healed by primary union. The convalescent period was unusually rapid as compared to that in other spinal conditions. The patient in Case I, whose occupation was that of counterman, consisting of long standing, bending and lifting, returned to his usual work four months after the operation. Case II, a younger man, returned to his strenuous job as truckman three months after the operation. Case III, a policeman, proved very interesting on account of our inability to control him postoperatively. Three days after operation we found that patient sitting up in bed. At the end of four weeks, being entirely without symptoms, he was allowed to leave the bed with the aid of a Knight spinal brace. At the end of ten weeks, he returned to his regular patrol duties. Case IV, the youngest patient, was up and about within eight weeks. The patient in Case V, because of long duration of infection prior to operation remained in the hospital for two months. The brace was discarded six months after operation. She married and became a mother within two years after operation. This is a different picture than one finds in tuberculosis of the spine, even after spinal fusion.

When these convalescent facts are compared with the general experience of transversectomy and drainage, we are particularly impressed with the great comparative difference. There has been no evidence in any of these cases of relapses or recurrences. It is to be noted that all of these patients have shown a rapid gain in weight following the operation.

4. *Rapid Regeneration.* The reparative processes, as shown by the *x*-rays taken postoperatively, demonstrate in a practical way what many in their writings have shown experimentally. (Gallie and Robertson[10] and Leriche and Policard.[11]) Apparently, the final course of disease is not only favorably influenced by the direct effect of complete immobilization, but from the experimental work of the above quoted authors one gains the information that the graft also establishes an increased blood supply, and, therefore, increased cellular nutrition. With this increased blood supply brought about by the extension of newly formed blood vessels, there occurs not only the introduction of immunizing factors to combat the infection but also the osteogenetic factors which influence more rapid regeneration. Bony coalescence of the affected bodies is noted in Cases I, II, III, and V, which showed marked bony destruction prior to operation. In Case IV, one notes that previous to operation the *x*-rays showed an irregularity and erosion of the lower articular margin of the second lumbar and the upper articular margin of the third lumbar vertebra. Six months after operation, there is present a re-establishment of the normal markings of both articular ends. (Fig. 18.) The only evidence remaining of the disease is a comparative narrowing of the intervertebral space. Due to the new bone formation all pre-existing evidences of buckling deformities are markedly diminished in our cases. A further interesting observation in these cases is that the grafts in all cases have practically retained their original size with distinct continuity of the trabeculae from the graft to the spinous processes.

5. *Fate of the Abscess.* Frequently, repeated *x*-ray examinations showed a rapid retrogression of the existing abscess formation in our cases. The previously existing evidences of mediastinal widening noted in the original *x*-rays of the first three cases cited is at present not discernable. Numer-

ous reports are present in the literature of the slow disappearance of abscess formation accompanying tuberculosis of the spine. In comparison, the abscess formation noted in our study disappeared more rapidly than the tuberculous abscess, probably, because in the former, no peri-inflammatory fibrosis sufficiently dense to prevent absorption has had a chance to form. The fate of this mediastinal involvement has been a subject of interesting study. While no biopsy studies are available in our cases nor any experimental data, which is exactly comparable to the events noted in the resolution of the apparent mediastinal inflammatory lesions, the factors involved can be discussed with a considerable degree of certainty.

As was pointed out earlier, the blood vessels in the vertebral bodies are especially rich in histiocytic cells lying in rather close relation to the lining endothelial wall. Furthermore, the point of intimate almost unified connection of periosteum to cortex was stressed. These two factors make available a rich blood supply and a large supply of phagocytic cells, easily mobilized, and close to the site of inflammation. It apparently requires only a rest factor to overbalance the recurring destruction of these phagocytes in the continuing inflammation in favor of resorption. This is supplied by the simple rest obtained in a plaster jacket or frame, but is apparently far more efficaciously performed by the bone transplant. The bone transplant by its power of fixation, produces a freedom from the progressing destruction caused by the continuation of the immobility of the vertebral segments.

The graft also acts by increasing local vascularity (phenomena of inflammation) by virtue of its continuous mildly irritative influences. In the light of the studies by Besredka,[12] such an influence heightens the local immune factors chiefly by the development *in loco* of defensive enzymatic immune bodies (cytolytic ferments). Menken,[13] further showed that a large part in the elaboration of such bodies is played by the hystiocytic cells and that in turn, the growth of such cells is accentuated by the continuous sterile inflammatory factors (mild continuing trauma). According to Rich,[14] the increased flow of fluid from the blood vessels into the surrounding tissues during inflammation serve the beneficial purpose of diluting and so rendering less irrigating any injurious substances liberated by infecting bacteria.

In addition to this diluent effect, the fluid that exudes contains specific neutralizing antitoxins and antibodies which cause local fixation and destruction of the infecting organisms. The presence of this continuing inflammation causes an increased flow of lymph from the affected area, thus flushing the site and irritating products of cellular destruction are washed away by a moving stream of the fluid. It is further confirmed by numerous other workers, Field, Drinker and White,[15] Bezanion and Labbe[16] and Menkin and Freund,[17] that at the height of inflammatory reaction produced by even sterile irritants the lymph draining from these areas contains many polymorphonuclear leukocyte cells which are not present in normal lymph. For our purpose we can conclude that all above mentioned factors give rise to resorption of the already formed inflammatory products, and in the cases presented make for the disappearance of the abscess.

General Comment. In this study both in the review of the literature and the clinical progress of our cases, one is strongly impressed with the value of correlated analyses of pathological, bacteriologic and immunologic interrelationship in the practice of the surgeon who is frequently confronted with the problems of infection. In this study, we have gleaned many facts of the why and wherefore in the utilization of local tissue reactions especially as it applies to the resolution of invaded areas that subside without surgical intervention. It offers an explanation in regard to the rationality of present conservative therapeutic status of acute osteomyelitis. In it we also find why many cases of primary

suturing in both osteomyelitis and in compound fractures have succeeded.

CASE REPORTS

Case 1. B. R., age forty-five, a white male, was suddenly seized with chills, fever and general malaise on March 1, 1930. Four days later he developed generalized joint pains of the upper extremity and the back and was treated for arthritis for three weeks by rest in bed and medication. He then developed a swelling near the right shoulder, which was diagnosed as an acute osteomyelitis of the right clavicle. The patient was removed to a hospital where an operation was performed consisting of incision, curettement and drainage. A culture taken at the time of operation proved to be a Staphylococcus aureus. At the end of two weeks he was discharged from this hospital. One month after this operation with clavicular wound still draining, the patient began to experience severe pain in the interscapular region. This pain gradually became worse and caused the patient to again become bedridden for six weeks. He was then advised to go to Mt. Clemens for his rheumatism of the spine; he remained there for six weeks becoming progressively worse with increasing pain, frequent chills, profuse sweating and loss of weight. Finally, he was seen by Dr. S. Klein, of Detroit, who told him that he was suffering from an infectious spondylitis. A high plaster body cast was applied giving the patient sufficient relief to be enabled to return to his home. Through the courtesy of Dr. Klein, he was referred to us for further care.

When first seen at our office the patient still presented signs of sepsis and complained of severe pain in his back. The cast was bivalved and examination showed a localized swelling and point of tenderness over the eighth and ninth dorsal segments. Motion of entire spine was markedly limited on account of pain. *X*-ray taken at that time showed a degeneration of the adjacent surfaces of the eighth and ninth dorsal vertebrae with the presence of bony proliferation. *Diagnosis:* Osteomyelitis affecting the eighth and ninth dorsal vertebrae. The patient was admitted to the Jewish Hospital of Brooklyn, August 13, 1930.

On admission his temperature was 100.4°C.; pulse, 120; respiration, 26. He had had frequent attacks of renal colic for fifteen years. His last attack occurred eighteen months previously, when he was treated by crushing through a cystoscope. Other tracts were normal.

Physical examination revealed an adult, well developed male, who coughed from time to time and appeared anxious and sick. The patient presented a chronic septic appearance, was markedly cyanotic and dyspneic. The cough was accompanied by very little expectoration, but there was marked hoarseness. The left pupil was irregular and drawn to one side due to injury during childhood. There was a scar over the outer half of the right clavicle reaching to the shoulder, marked induration of the right clavicle, no tenderness and no palpable glands. The heart was not enlarged. There were sounds of valvular quality at the apex and no murmurs nor irregularities. Percussion showed slight dullness in the right apex anteriorly due to callosity of clavicle. Breath sounds were harsh over right scapular, apical and infraclavicular regions, as compared to similar areas in opposite side. Coarse ronchi and transmitted tracheal rales were heard throughout. Impression: chronic bronchitis and tracheitis.

There was limitation of spinal motions especially in the dorsal region. Pain was present on forward flexion of cervical region and increased heat sensation in the lower dorsal region. There was marked tenderness over areas corresponding to eighth, ninth and tenth dorsal vertebrae and moderately increased dorsal kyphosis with moderate gibbous formation at the level of the eighth dorsal vertebra.

Red blood count was 4,740,000; hemoglobin, 85 per cent; white blood count, 12,600; polymorphonuclears, 76 per cent. Urine on two examinations was negative except for a few white blood cells. Sputum on three examinations showed no elastic tissue and no T.B.C. Blood pressure, 130/84; blood culture, negative.

X-ray examination, August 14, 1930, showed marked narrowing and irregularity of the eighth and ninth dorsal vertebrae. The interspace, however, appeared intact and no wedge-shaped appearance was observed. The proliferation of bone to a slight degree was noted. A surrounding opacity obtained, suspicious of a radio-opaque abscess. In view of the clinical findings and the history of bone infection in another part of the body, one must look upon these findings as infectious (osteomyelitis). (Figs. 1 and 2.)

The patient was kept in bed for a week and suitable medical treatment given for his

bronchial condition. During this period a bivalved body cast was prepared for postoperative care.

taken at that time are shown in Figures 3 and 4.

Case II. M. R., age twenty-one, a male,

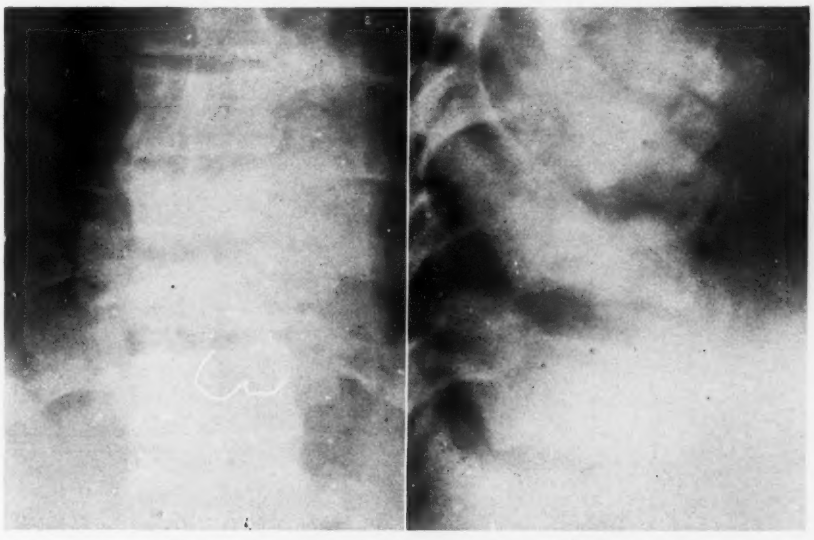

Fig. 1. Fig. 2.

Figs. 1 and 2. Case 1. Anteroposterior and lateral views, showing narrowing irregular destruction of articular ends between eighth and ninth dorsal vertebrae; large surrounding opacity indicating mediastinal abscess.

On August 22, 1930, a fusion of spine was performed according to the Albee technic, employing a heavy crest graft from the left tibia, six inches long and inserted into the split and denuded spinous processes of the sixth, seventh, eighth, ninth, tenth and eleventh dorsal vertebrae.

Convalescence was uneventful and the patient's general condition good throughout. Temperature, pulse and respirations were practically normal throughout. There were no complaints referable to local spinal condition. The wounds of back and leg healed readily. The patient was kept in bed for six weeks, during which time he was fitted with a Knight-Taylor spinal brace and allowed out of bed wearing this support. He began to walk at first with the aid of crutches and was discharged from the hospital, October 18. He was sent to a convalescent home for several weeks.

In January, 1931, he discarded the brace and returned to work as a counterman. Outside of an occasional attack of bronchitis, the patient has had no pain in back or chest since discharge. He was last seen for check-up on January 12, 1939, nine years after the operation. There has been no recurrence except for an attack of renal colic (right side) three years ago. He has been continuously at work and has gained over sixty pounds in weight. *X*-rays

white truck driver, was confined to bed with a cold and pains in the chest four weeks prior to admission. He remained at home for about a week and then returned to his work feeling very weak. Six days previous to admission, he began to experience severe sticking pains in the right chest radiating to the right axilla. These pains were aggravated by deep breathing and coughing. On the following day, he became very feverish and subsequently began to experience severe headaches. Two days before admission he noted that his neck and back became stiff and he had great difficulty in turning. The patient was admitted to the Medical Service of the Beth-El Hospital, May 26, 1931. On admission, his temperature was 104°F., pulse 100, respiration 22.

Physical examination revealed a young white male, twenty years old, acutely ill. Sternomastoids were very tender to pressure. His head could be rotated from side to side with pain. There was rigidity of the neck and pain on attempt to flex head. A slightly palpable thyroid was present. The following were also found: Slight lag in right lower chest; no change in tactile fremitus; good resonant note throughout except in the upper right axilla and also slight impairment in the right base posteriorly; no friction rub or rales; breath sounds clear in right axilla posteriorly. Breath sounds were

suppressed in right base. The heart was not enlarged. Sounds were of good quality, regular in rate and rhythm. No murmurs were present.

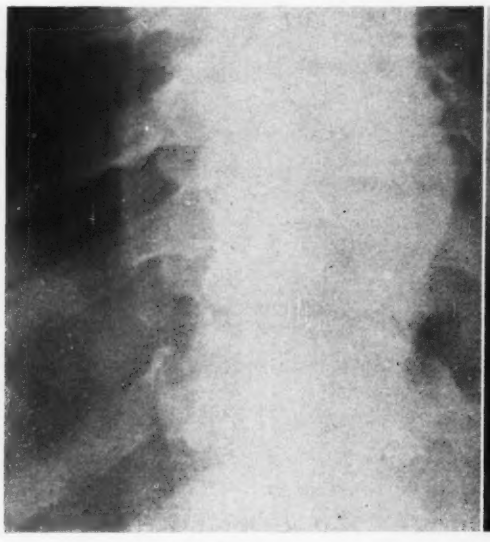

Fig. 3.

Fig. 4.

Figs. 3 and 4. Case 1. Anteroposterior and lateral views taken nine years later showing complete bony coalescence of eighth and ninth vertebrae with disappearance of mediastinal widening.

The abdomen showed slight general spasticity and no tenderness. No organs or masses were felt. Back examination revealed no evident signs of deformity, but there was marked rigidity of the entire spine. Marked tenderness was localized to the region of the seventh and eighth dorsal vertebrae. The extremities showed no purpuric spots. Patellar reflexes were not obtainable. The Kernig reflex was present and explained on account of the existing generalized myalgia. No Babinski nor Oppenheim reflexes were present and no sensory or motor disturbances were noted in both upper and lower extremities. There was generalized myalgia with severe pain on pressure of almost any muscle in body.

Laboratory findings were as follows: Urine examinations (18 specimens)—in one specimen a trace of albumin was found, otherwise there were no abnormal findings. Blood: White count ranged from 20,600 to 10,000; polymorphonuclears ranged between 84 and 76; glucose 118, urea N. 14.2, creat. 1/57; cultures were sterile three successive times; the Widal text was negative, repeated four times. Cerebrospinal fluid—Clear, albumin +, globulin +, sugar reduction +++, cell count 2 to 15 per field (lymphocytes), no T.B.C. Culture was sterile. Feces—no typhoid bacilli found.

During the first four weeks he ran a temperature ranging between 102 and 104°F. then an irregular one between 99 and 101°F., reaching 103° on two different occasions up to date of operation which was eight weeks after admission. During this time, repeated *x*-rays were taken of chest showing definite hilum opacity on right side consistent with central pneumonia. The cerebral spinal fluid was examined several times because of a suspicion of tuberculous meningitis. The medical opinion was of a central pneumonia with meningismus. On September 13, four months after admission to hospital, the patient was first seen by us on account of rigidity of back and persistent complaint of pain in this region.

The patient was lying in an opisthotonus position. Examination at first was very difficult on account of extreme pain even when bed clothes were touched. A gibbous deformity was noted in the region of the eighth dorsal vertebra and there was marked tenderness over that point. The soft tissues surrounding showed evidence of infiltration. A portable *x*-ray was taken of the dorsal region which showed a narrowing of the seventh and eighth dorsal vertebrae with evidence of bony proliferation anteriorly and of abscess formation anterior to the spine.

The patient was placed on a Bradford frame which apparently gave some symptomatic relief at times, but he was very difficult to handle. Agonizing pain persisted especially when the

patient was touched or moved. Another *x*-ray taken two months later was reported as follows: "There are destructive changes involving the bodies and articular surfaces of the 7th, 8th and 9th dorsal vertebrae. The 8th dorsal vertebrae is almost completely destroyed. There is a soft tissue shadow embracing the spinal column in the involved region (paravertebral collection)." (Figs. 5 and 6.)

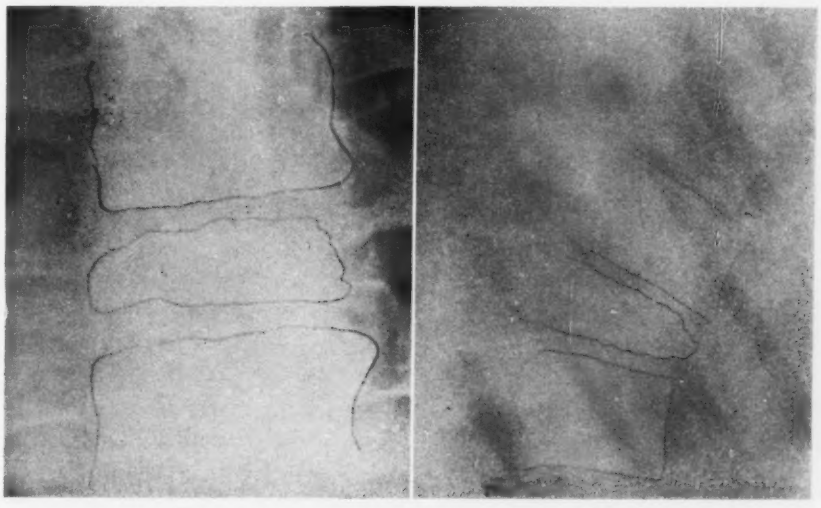

Fig. 5. Fig. 6.

Figs. 5 and 6. Case II. Anteroposterior and lateral views showing destructive changes involving seventh, eighth and ninth dorsal vertebrae; eighth completely involved; marked mediastinal widening.

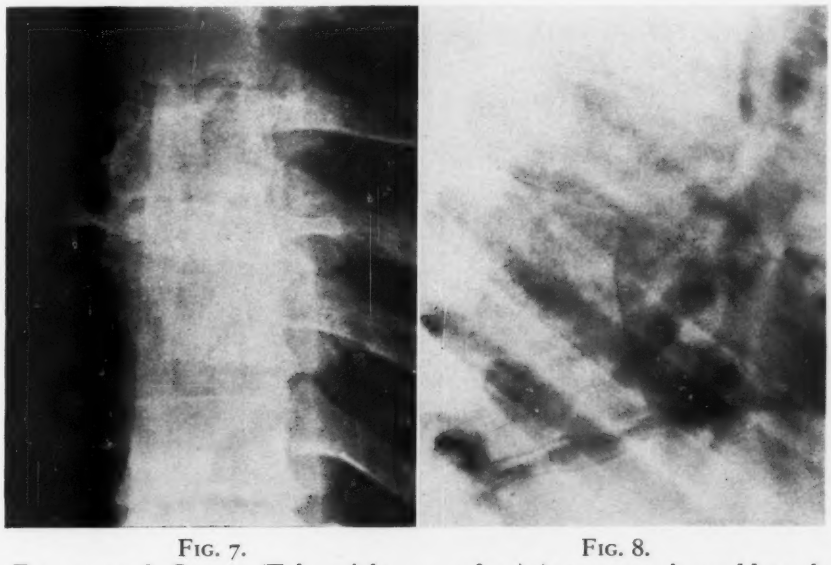

Fig. 7. Fig. 8.

Figs. 7 and 8. Case II. (Taken eight years after.) Anteroposterior and lateral views showing coalescence of vertebral bodies; disappearance of mediastinal opacity.

In comparing the above *x*-ray reports, there is noted a distinct increase in the destructive process despite the patient's fixation on the Bradford frame.

Operation was performed October 21, 1931, consisting of a spinal fusion, according to the Albee technic. There was no postoperative reaction. One week following operation, the temperature reached normal for the first time and remained so throughout his stay in the hospital until December 16, 1931 when the patient was discharged wearing a Knight-Taylor brace, walking around comfortably.

Two months after discharge from the hospital, the patient reported that he was back at work driving a truck. He discarded the brace because it interfered with his work and was

free of any symptoms. Patient was seen at our office January 17, 1939, at our request. Check-up examination showed perfect healing at site of operation eight years after operation. *X*-rays show definite coalescence of seventh, eighth and ninth dorsal vertebrae. No mediastinal widening was noted. (Figs. 7 and 8.) He has had no symptoms or complaints of any kind referable to his back.

Case III. A. J. D., age twenty-six, a white male, suddenly experienced pain in the right iliac region on September 9, 1932. He attributed the pain to a strain produced by stopping a runaway horse one day previous. The patient was taken to Cumberland Hospital, Brooklyn, where an operation was performed for appendicitis. Report of pathological findings of the operation from the records of said hospital showed an obliterative appendix with periappendicitis. Peritoneal drainage was employed. Three days postoperatively while being turned he experienced a sharp pain in the lower thoracic spine. The patient remained in bed for twenty-six days. When leaving the bed the back pains recurred. He remained in the hospital for six weeks. *X*-rays of chest were examined for any spinal pathological condition but none were noted. The day after his discharge from the hospital, he was re-admitted to another hospital because of a severe attack of left chest pains and a rise in temperature. In the records of the Greenpoint Hospital, we find the admission diagnosis reading, "Left apical pneumonia, subhepatic abscess and bilateral pleuritis." These diagnoses were not confirmed by laboratory or roentgenological examinations. After running a febrile course for about four weeks, the temperature finally subsided and after being afebrile for a week he was discharged. Upon discharge the patient still complained of pain and stiffness of the back.

On January 6, 1933, three days after discharge from Greenpoint Hospital, the patient experienced an acute, severe, sharp pain in the right lower quadrant which became progressively severe until the pains became intolerable. Pain described as agonizing, severe, sharp, knife-like, seemed to pass through to the back; there was no radiation to thigh or penis. He vomited twice and was then admitted to the Urological Service of The Jewish Hospital, Brooklyn.

On admission his temperature was 99.6°F., pulse 96, respiration 22. Physical examination generally was irrelevant and negative. Abdomen revealed a scar (right pararectus), tenderness on deep pressure in the right lower quadrant two inches lateral to the scar. Rectal examination was negative.

Surgical Consultation: Flaccid abdomen, no spasticity, rigidity or tenderness. Impression: surgically—negative. Right nephrolithiasis was suspected. Cystoscopy and intravenous pyleography did not confirm diagnosis. There were no areas of hyperesthesia or anesthesia, but there were bilateral clonus, questionable Babinski, protective fixation of muscles of the spine, and voluntary movements were performed with difficulty. There was marked limitation of motion of the spine in the entire dorsal region with buckling of the eighth dorsal vertebra, localized spinal muscle spasticity, no thermal changes over point of pathology and no evidence of muscular atrophy in the lower extremities.

Impression: Osteomyelitis of the middorsal vertebra. A Bradford frame was advised.

The only evidence of possible cord involvement was the inexhaustible ankle clonus. There was no evidence of a segmental lesion. There was indefinite hyperalgesia over the back and abdomen D7 to L2, which was most marked in the region of D8 and tenderness over D8 vertebra. Sensory changes and decreased motor power of the spinal muscles suggested radiculitis.

X-rays taken on September 10, 1933, showed both kidneys normal except for a small opaque shadow in the left lumbar region apparently cast by calculus in the lower calyx of kidney. This shadow persisted in all renal plates. Pulmonary study revealed bilateral hilum infiltration with no evidence of localized pathology. The cardiac shadow was within normal limits of size, shape and position. *X*-rays on January 12, 1933, showed evidence of a destructive process of the body of the eighth dorsal vertebra. The intervertebral spaces were not involved and there was a suggestion of degeneration of the anterior portion of the body which had partially collapsed but not completely so. A metastatic osteomyelitic process might readily account for these findings. This conclusion was favored rather than Koch or neoplasm. *X*-rays on January 28, 1933, confirmed previous report. Further, the intervertebral space below, however, was definitely involved as was the upper portion of the

adjacent vertebral segment. One did not note the characteristic rarefaction that is usually observed with tuberculosis, but the findings believe the process to be of an osteomyelitic nature. (Figs. 9 and 10.)

Urine on admission showed 1 plus albumin;

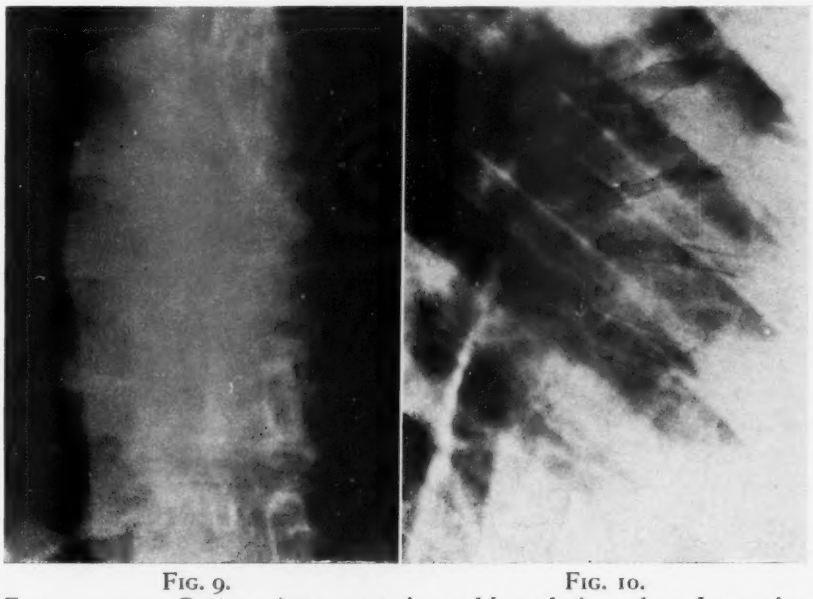

Fig. 9. Fig. 10.

Figs. 9 and 10. Case III. Anteroposterior and lateral views show destructive involvements of eighth dorsal vertebra with secondary degenerative process of contiguous vertebrae seventh and ninth; definite mediastinal widening.

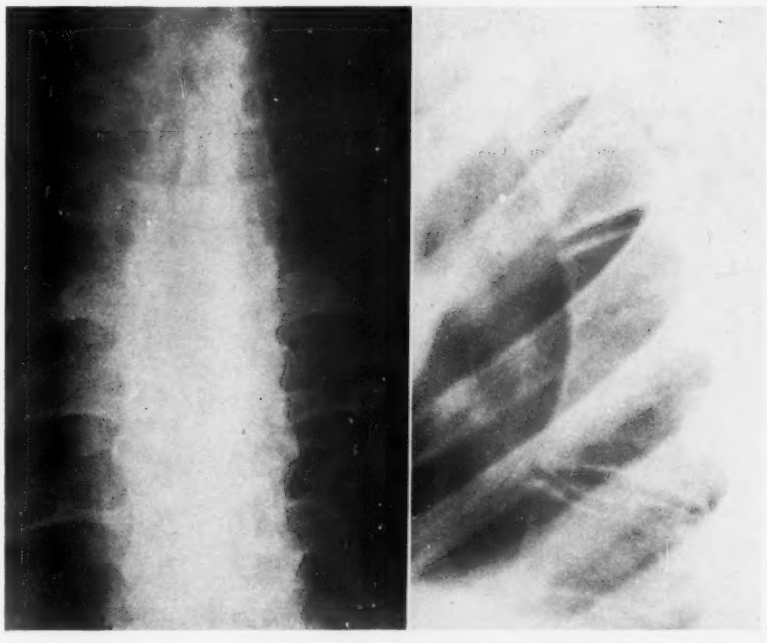

Fig. 11. Fig. 12.

Figs. 11 and 12. Case III. Anteroposterior and lateral views showing complete ankylosis of seventh, eighth and ninth vertebrae; mediastinal widening diminished.

would otherwise fit in with same. Opinion was uncertain as to whether this was tuberculosis or secondary osteomyelitis, but in view of the involvement of the contiguous vertebrae, indicating a rapid progression, we were inclined to

5 to 10 red blood cells hpf., occasional white blood cells and crystals. On repeated examinations these pathological elements were not observed. Blood chemistry was normal; Wassermann and Kahn tests were negative. White

blood cells, 13,650 and 14,000; polymorphonuclears 89 per cent on admission, 82 per cent later; blood culture was sterile.

The patient was accepted on the Orthopedic Service on January 20, 1933. He was placed on a Bradford frame with head traction. On February 6, 1933, an Albee spine fusion was performed under gas-oxygen ether anesthesia with a six inch graft from the right tibia inserted between D5 and D11. Immediate reaction was good. For several days postoperatively the temperature curve was markedly irregular. He developed a respiratory infection and four days later the temperature returned to a flat normal level. On March 15, 1933, a spine brace was applied. Wounds healed per primam. The patient was discharged on March 16, 1933, markedly improved and was referred to the out-patient department for follow-up. He was seen several times in the out-patient department and his condition was found to be excellent.

The patient returned to his regular duty as patrolman on May 1, 1933, or less than three months postoperatively. His general condition was very good. He discarded his brace when he returned to duty as he had absolutely no symptoms. He has gained 54 pounds since the operation and has had no signs or symptoms of recurrence, except for pain at the point of incision during inclement weather. On December 18, 1938, *x*-rays showed complete coalescence between the eighth and ninth dorsal vertebrae, the graft in situ and no evidence of mediastinal widening. (Figs. 11 and 12.)

Case IV. L. D., aged 14, Italian school boy, was admitted to the medical service on September 11, 1933, complaining of pain in the lower part of the spine for nine days and fever for eight days' duration.

Three weeks prior to admission the patient had a mild cold associated with cough and expectoration but remained ambulatory. Nine days prior to admission he developed severe pain in the lower part of the back which was aggravated on walking. The following day he was compelled to go to bed. His temperature rose to 100.6°F. and thereafter maintained a level between 103 and 104°F. Pain occurred in the lower part of the back, sometimes excruciating, radiating anteriorly to the abdomen; it was aggravated by coughing and straining at stool. On the night of admission he developed severe paroxysms of coughing and cramp-like pain in lower portion of his back. He vomited once since the onset of illness. There were no subjective neurological symptoms, no trauma, no urinary difficulties and no rheumatic manifestations.

He had had diphtheria at seven, asthma at nine, a sore throat once a year and cervical adenitis three years previous.

On admission his temperature was 101.2°F., pulse 98, respiration 24. He was a well developed boy, flushed, acutely ill, holding the left side of his abdomen. There were no respiratory difficulties. Two maculopapules were on the skin of the thorax. Pupils reacted to light and accommodation; extra-ocular movements were good; nasal and pharyngeal mucosae were congested; there was moderate tonsillar adnopathy but no nuchial rigidity. Flexion of spine elicited low spinal pain. Lungs and heart were normal, abdomen voluntarily rigid and no direct tenderness or rebound tenderness.

The entire spine was held rigid especially over the lumbar region with no flexion or lateral motion. There was tenderness of second and third lumbar vertebrae and in surrounding musculature, tenderness and limited motion in internal rotation of right thigh, and no sacroiliac pain. There was a suggestion of Kernig reaction with diminution of knee jerks bilaterally. The spine showed a kyphotic state extending from the tenth dorsal to fourth lumbar. Flexion and extension of the spine in the lumbar region was markedly limited on account of muscular rigidity, which was palpated on either side of the spine. Marked tenderness was located over the second lumbar vertebra. The patient presented a bilateral psoas spasticity with resultant limitation of hip extension. There was a suspicion of infectious arthritis or osteomyelitis of the second lumbar vertebra.

An *x*-ray on September 14, 1933, of the dorsal and lumbar spines was negative. (Fig. 13.) An *x*-ray on October 7, 1933, showed a narrowing of the intervertebral space between the second and third lumbar vertebrae, and beginning erosion of the upper margin of the third lumbar vertebra. (Fig. 14.) An *x*-ray on October 16, 1933, showed the narrowing of the intervertebral space to be more marked, an increase of the rarified area of the upper part of the third lumbar vertebra, and beginning signs of necrosis in the lower border of the second lumbar vertebra. (Fig. 15.) Five days later an *x*-ray showed advancement in the degree of

narrowing of intervertebral disc and increasing signs of necrosis of the articular margins. (Fig. 16.)

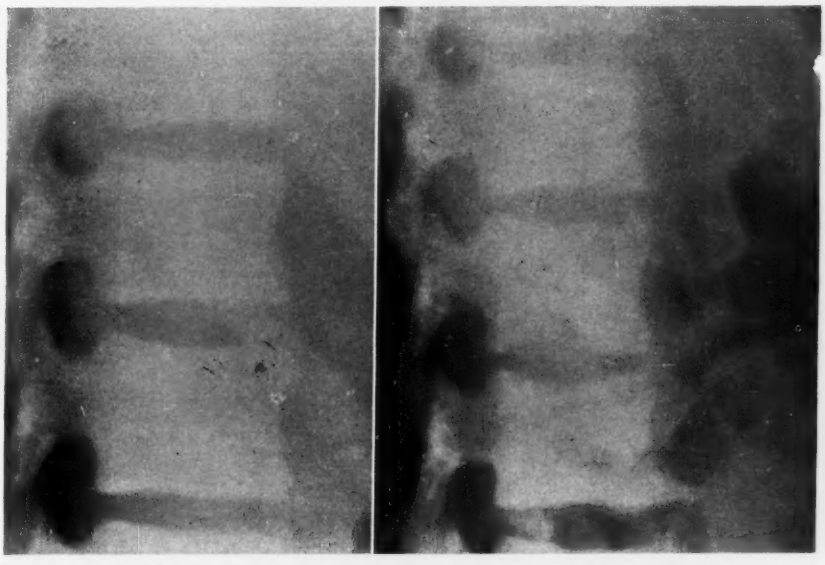

Fig. 13. Fig. 14.

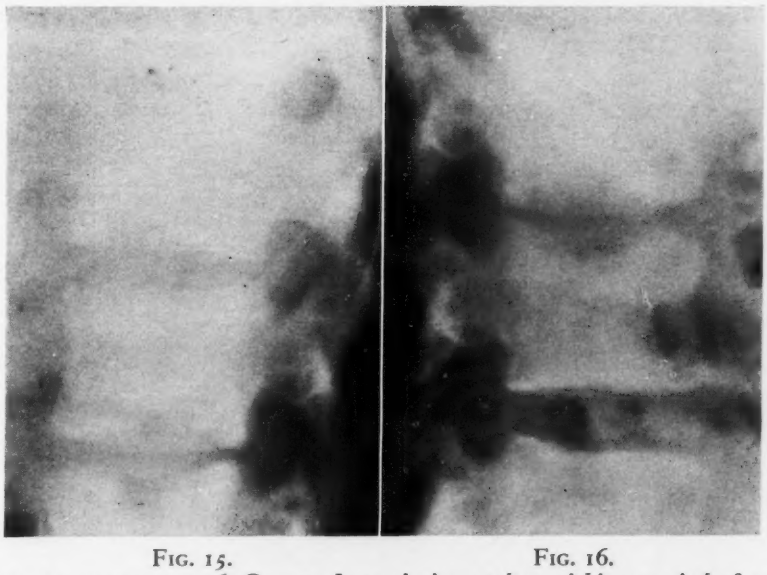

Fig. 15. Fig. 16.

Figs. 13, 14, 15 and 16. Case IV. Lateral views taken within a period of one month and showing advancing processes of degeneration affecting second and third lumbar vertebrae.

Laboratory examination revealed the following: Urine: several specimens showed no unusual elements; blood on admission: white blood cells, 25,000; 86 per cent polymorphonuclears; preoperative blood: white blood cells, 9,600; 81 per cent polymorphonuclears; red blood cells, 4,700,000; 75 per cent sahli; chemistry: normal; Wassermann and Kahn tests: negative; culture: nine-twelfths, Staphylococcus aureus, 100 col.; nine-fifteenths, Staphylococcus aureus, in broth only. Bacteriology: No agglutination B. typhosus, para A and para B; urine and stool showed no B. typhosus. Spinal fluid: Bloody fluid, sterile culture, no organism; Wassermann and Kahn tests: negative. Old tuberculin skin test: 0.1 mg. negative; 1.0 mg. and repeat suspicious.

Five days after admission the patient became more comfortable. T.P.R. were within normal limits, but symptoms persisted to a lesser degree. On October 7, the patient was accepted on the Orthopedic Service and was maintained on a Bradford frame for fourteen days.

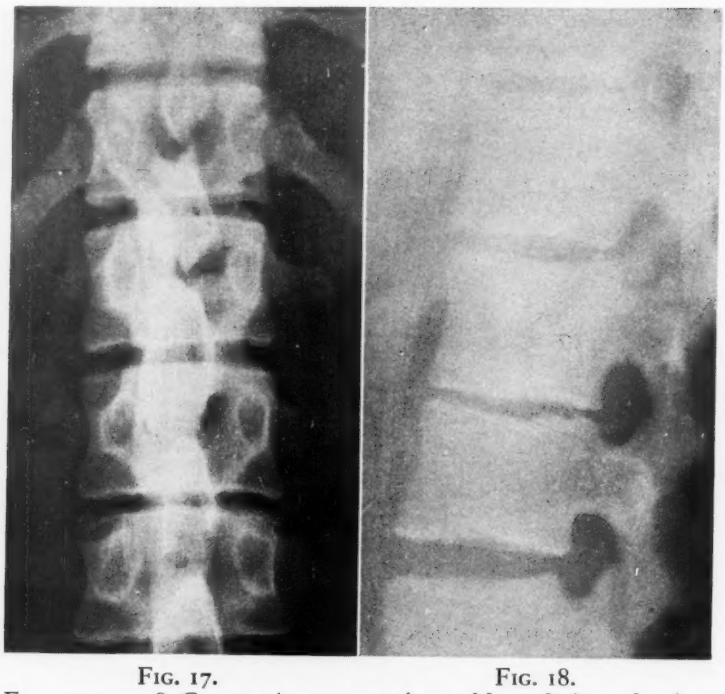

FIG. 17. FIG. 18.

FIGS. 17 AND 18. Case IV. Anteroposterior and lateral views showing complete regeneration of bony erosions. Only a slight narrowing of intravertebral space remains.

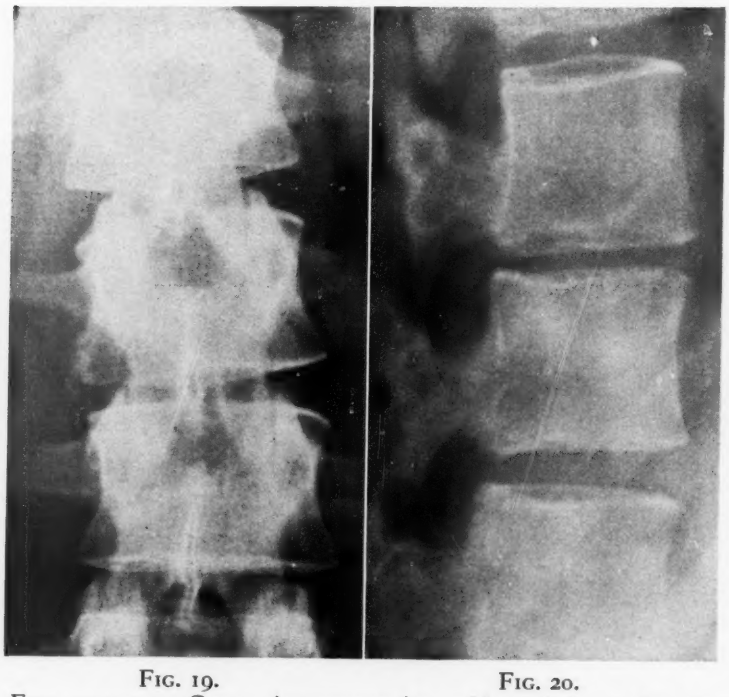

FIG. 19. FIG. 20.

FIGS. 19 AND 20. Case V. Anteroposterior and lateral views taken six months prior to operation showing loss of cortical substance on inferior portion of body of second lumbar vertebra. On right side note a beak-like new bone formation.

On October 23, under gas-oxygen-ether anesthesia, an Albee spine fusion was performed with a six inch graft from the left tibia inserted between D12 and L5 and the patient was placed in a body cast previously prepared.

Postoperative reaction was good. Leg and back wounds healed per primam. On December 4, a back brace was applied and the patient was permitted out of bed. He was discharged December 6, 1933, and referred to a convalescent home. He is seen regularly in the outpatient department; he is ambulatory and still wearing brace; his condition good.

X-rays taken of the lumbar-spine December 29, 1933, show upper articular margin of the third lumbar and lower articular margin of the second intact in outline. Brace was removed. The only existing evidence as shown on the last plate is the intervertebral narrowing which appears less marked now than previous to operation.

At the last examination, December 17, 1938, the patient was very well; he had had no symptoms or disability since discharge and has been attending school regularly. Objectively, he showed a really normal back except for operative scar. *X*-rays taken the same day show a very slight narrowing between the second and third lumbar vertebrae. Articular margins are regular and distinct. (Figs. 17 and 18.)

Case v. M. R., age twenty-one, female, white, was admitted to Beth-El Hospital, December 22, 1934. Three months before admission while attempting to sit down, the chair pulled away and the patient fell to floor. Developed pain in the lower part of her back which cleared up within a few days. Two months before admission the pain returned with severe intensity. This pain started in the right lumbar region and later began to radiate anteriorly to the inguinal region and right hip. Pain became increasingly worse at night preventing sleep. She had her back strapped and then wore a plaster corset which aggravated pain. The patient's past history was irrelevant; she had had no other sickness except those of childhood. Temperature on admission was 99.8°F., pulse 116, respiration 22.

Physical examination revealed a very well developed, white female, not acutely ill and all other tracts essentially negative. The patient was unable to sit up without aid. There was marked tenderness over the second and third lumbar vertebrae and bilateral erector spinae spasm. Motions were restricted in all directions especially in hyperextension of the lumbar spine. Straight leg raising was markedly restricted bilaterally; hyperextension of hips produced pain in the lumbar spine and marked bilateral psoas spasm was present.

Blood count: Red blood cells, 4,400,000; hemoglobin, 85 per cent; leukocytes, 9,100; polymorphonuclears, 76 per cent. Urine was negative.

X-rays taken on December 22, 1934, showed a loss of cortical outline on the inferior portion of the body of the second lumbar vertebra. On the right side of the body one noted a beak-like new bone formation. Impression: Low grade osteomyelitis or tuberculosis. (Figs. 19 and 20.)

A body jacket was applied on December 28, 1934. During this stay in the hospital the patient ran a low grade temperature with few nocturnal rises to 101°F. She was advised operation because a subsequent *x*-ray taken February 8, 1935, showed greater amount of bone erosion and increased narrowing of the intervertebral space between the second and third lumbar vertebrae. Operation was refused by the family. A Knight spinal brace was applied and the patient taken to Florida on March 6, 1935. She returned in four weeks and reported to our office. A definite buckling was noted with exacerbation of clinical symptoms. Operation was again advised. After few consultations with various men in New York and Brooklyn, the patient returned to my care and was re-admitted to Beth-El Hospital on April 28, 1935. *X*-rays taken April 30, 1935, showed an absence of bony substance of the posterior and inferior one-half of the body of the second lumbar vertebra, right side and extending into articulation. There was a well defined proliferative bony area about this rarefaction and a marked narrowing of the interspace between the second and third lumbar vertebrae. There was also noted a thinning of the inferior portion of the left side of the second lumbar body with some evidence of periosteal reaction. *X*-rays taken of chest showed no evidence of parenchyma infiltration nor pleural involvement. (Figs. 21 and 22.)

Operation was performed on May 3, 1935, under general anesthesia. An Albee spinal fusion was performed. The postoperative reaction was good and convalescence was uneventful. Leg and back wounds healed per primam. She was discharged on July 8, 1935.

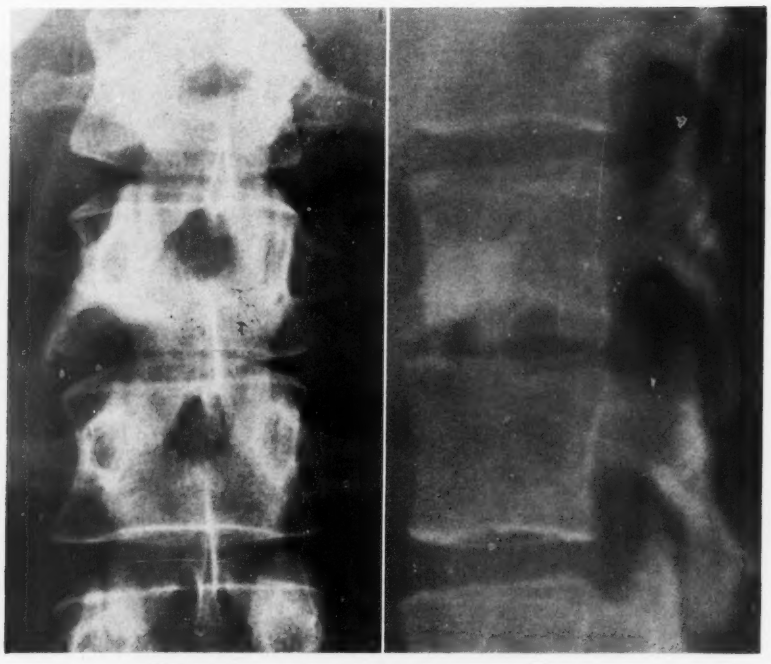

FIG. 21. FIG. 22.

FIGS. 21 AND 22. Case v. Anteroposterior and lateral views taken prior to operation showing definite articular erosion of inferior surface second and superior surface third lumbar vertebrae; rapid advancing degeneration as compared to Figures 19 and 20.

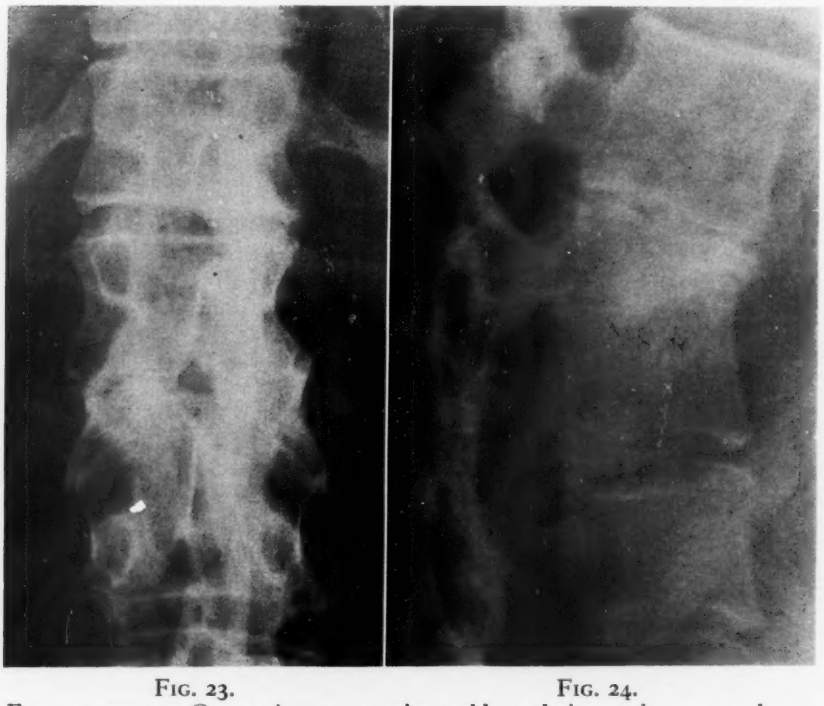

FIG. 23. FIG. 24.

FIGS. 23 AND 24. Case v. Anteroposterior and lateral views taken one and one-half years after operation showing marked narrowing of interspaces between first and second and second and third lumbar vertebrae; texture of bone same as in uninvolved vertebra.

The patient wore a brace for three months following discharge from the hospital. The last *x*-rays taken on November 18, 1936, showed marked narrowing of the second lumbar vertebra to one-half its original size. Articular margins were well outlined and regular and showed no evidence of the previously noted erosion. There was marked narrowing of the interspace between the second and third vertebrae. The density of the remaining portion of the body was definitely of the same texture as the bodies above and below. The graft was in situ. (Figs. 23 and 24.)

The patient married one year after her last discharge from the hospital. In February, 1938, I was requested to examine the patient in the Maternity Pavilion of the hospital after childbirth. She had a normal pregnancy and delivery of an 8 pound baby. She has had no symptoms referable to her back.

SUMMARY

1. Five cases of acute osteomyelitis of the spine, treated by tibial transplant fixation are reported. The clinical picture of the process is delineated, its differential diagnosis discussed and the radiographic picture presented.

2. The embryogenetic and anatomic factors in the production of the lesions are discussed. The vascular supply of the vertebral columns is discussed in detail because of its apparent intimate relationship with the processes of regeneration.

3. The rational for spine fusion is presented by means of tibial bone graft. It is shown that the postoperative reactions are absent; that convalescence is far more rapid and complete than by other methods of therapy; that bone regeneration in the affected vertebra is so rapid as to be concommitant with the immediate postoperative course. It is pointed out that prevertebral inflammatory processes radiographically demonstrated as abscesses or phlegmonous mediastinitis disappear without surgical drainage of the involved area. The probable factors in such retrogressive phenomena are discussed.

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EXTRUSION OF THE SMITH-PETERSEN NAIL IN INTRACAPSULAR FRACTURES OF THE NECK OF THE FEMUR*

F. I. SHATARA, M.D., F.A.C.S.
Attending Surgeon and Chief of Traumatic Service, Cumberland Hospital
BROOKLYN, NEW YORK

THE contributions of Smith-Petersen toward solving the problem of the unsolved intracapsular fracture of the neck of the femur have received general and well merited recognition. His work ushered in a new era in the treatment of patients with intracapsular fractures who were previously doomed to a life of recumbency, disability and suffering. The method of internal fixation, which he advocated in 1931,[1] greatly shortens the period of treatment and hospitalization, and permits patients to leave their sick beds within a few days after operation. It eliminates the dangers attendant upon long periods of recumbency or immobilization in plaster and is thus applicable to patients who were considered unsuitable for the older methods of treatment.

FIG. 1. S. M., intracapsular, midcervical fracture of neck of left femur.

But this method presents certain risks and difficulties which should be recognized and appreciated. The so-called open method of fixation in which an arthrotomy is performed and the hip exposed by the Smith-Petersen (iliofemoral) incision is a severe operation entailing an appreciable degree of shock. Because of the trauma involved in reflecting the gluteal muscles from the external surface of the ilium and the other steps necessary to obtain an adequate exposure, infection is not uncommon. It has also been observed that opening the capsule permits visual reduction and enables the surgeon to correct rotation of the head, the removal of interposed shreds of soft tissue, and the accurate introduction of the nail, but it renders apposition and maintenance of the fragments more difficult. In other words, reduction and maintenance are easier if the capsule is not opened. This has been explained by the compressing action of the

* From the Traumatic Service, Cumberland Hospital, Brooklyn, New York.

capsule which acts like a rubber tube put on stretch when the lower extremity is abducted.

Fig. 2. S. M., anteroposterior view after reduction and insertion of Smith-Petersen nail.

Fig. 3. S. M., lateral view showing nail in accurate position.

The foregoing considerations have led most surgeons to abandon the open operation in favor of the so-called semi-open approach through a lateral incision. This latter method entails little shock or danger of infection and the operating time is short.

However, there are certain mechanical difficulties inherent in the use of a large flanged nail. In the first place if during the first attempt the nail is not accurately placed, subsequent attempts are very likely to fail. This is due to the inevitable destruction of cancellous bone while driving the nail. In making the subsequent attempts, the amount of bone destruction is increased and a large tunnel may be formed which will not grip the nail firmly. In such cases firm fixation is not accomplished; motion between the fragments occurs and nonunion is the usual end result. Plummer[2] states: "In the majority of the younger patients, with good reduction and internal fixation, bony union can be expected. In the older patients, we probably must be satisfied with a satisfactory weight-bearing function and perhaps assume that the fixation nail will be the chief factor in maintaining a useful leg for these patients during the rest of their lives." If we accept this hypothesis, the necessity of firm fixation is apparent.

The second mechanical difficulty is inherent in the necessity of driving rather than drilling the nail. It is the writer's experience that drilling is more satisfactory than driving. Drilling is less likely to separate the fragments and gives a better grip.

FIG. 4. S. M., shows extrusion of nail and refracture of neck about eleven months later.

FIG. 5. S. M., after McMurray osteotomy.

FIG. 6. F. P., intracapsular, mid-cervical fracture of neck of left femur.

FIG. 7. F. P., anteroposterior view after reduction and insertion of Smith-Petersen nail.

Finally, the Smith-Petersen nail lacks a sharp, penetrating point, and is, therefore, less likely to secure a firm hold on the

Fig. 8. F. P., shows extrusion of nail about five weeks later.

capital fragment. It has been observed while inserting the Smith-Petersen nail with the capsule opened, that as the point of the nail impinges against the capital fragment, hammering the head of the nail tended to separate the fragments rather than draw them together. To overcome this difficulty, hammering on the special impactor should alternate with hammering on the head of the nail until the nail is driven through the head. A few sharp blows on the impactor should always be delivered before closing the wound.

But firm impaction is not obtainable in all types of intracapsular fractures and the writer strongly believes that a further subdivision or classification of intracapsular fractures is greatly needed. There is little doubt that the position of the fracture line, its inclination, the presence and extent of comminution are important factors in determining the end result. Leadbetter[3] states: "The type of fracture must also be considered for in fractures of the neck of the femur one sees not only transverse fractures, but also spiral, oblique and comminuted fractures. It is, therefore, just as difficult to maintain the position in a spiral

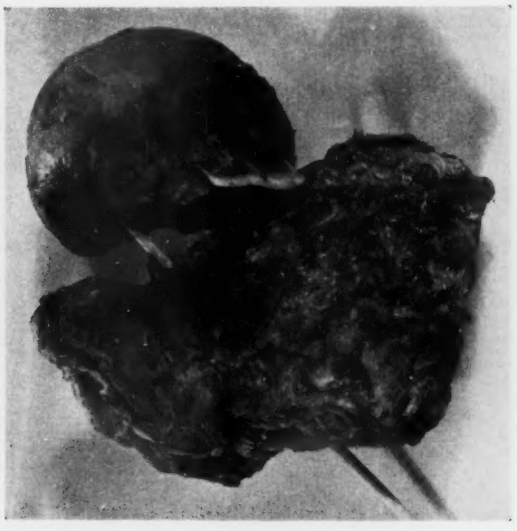

Fig. 9. F. P., specimen removed at autopsy showing complete absorption of neck. Steinman pin shows position of Smith-Petersen nail.

or comminuted fracture of the neck of the femur as in any other bone."

It may be helpful, whenever possible not to be satisfied with the diagnosis of an intracapsular fracture, and to further designate whether it is a subcapital, mid-cervical or basilar and to note the presence of comminution and the obliquity of the fracture line. If this is done, the varying end results reported may be more intelligently understood and evaluated. Planographic *x*-rays may be of aid in furnishing better visualization. Our experience with subcapital and comminuted fractures has been disappointing, and some day we may be driven to the position of admitting defeat in these cases and performing an osteotomy at the outset. Telson[4] classified twenty-five cases in which internal fixation was accomplished by the insertion of multiple steel wires and the subcapital variety gave the poorest end results.

Moore[5] states: "The nearer a fracture is to the head, the poorer is the blood supply; this explains why subcapital fractures are more prone to non-union than are fractures through the base of the neck.

"Another factor of great importance is that mechanically it is more difficult to maintain apposition in a subcapital fracture than it is in a basilar one. Healing of these fractures is governed by the rules of hyperemic decalcification and ischemic recalcification. When the fragments are imperfectly immobilized, the trauma of motion gives rise to increased and continued hyperemic decalcification with absorption of the neck and non-union. In subcapital fractures with non-union the neck is absorbed because the main source of blood supply comes up from the distal fragment and hyperemic decalcification takes place there. The head in such fractures may be almost entirely avascular; there is no absorption of its calcium content, and it shows up in the x-ray film as a dense hard sequestrum."

Fig. 10. J. M., intracapsular, midcervical fracture of neck of left femur.

There are not many reports in the literature regarding difficulties with the Smith-Petersen nail and the fragmentary information here presented has been gleaned from a study of available literature. A critical examination of the cases reported by Smith-Petersen et al. in 1931[1] shows that in five out of twenty-four cases reported there was some difficulty with the nail. Thus in Case I, although the nail was driven into the head at the time of operation, subsequent "roentgen examination showed that the nail apparently did not enter the head." In Case III, there was nonunion and absorption of the neck and the nail had to be removed. The *x*-ray prints suggest extrusion of the nail. In Case IV, the nail had to be removed because there was evidence of bursa formation around its head with pain and tenderness. In Case V, "the nail which was somewhat loose and corroded was removed." In Case VIII, the direction of the nail had to be altered at the time of operation. About seven months later there was a refracture of the neck with extrusion of the nail and a Whitman reconstruction had to be performed.

Watson-Jones[6] states: "It might be thought probable that absorption of bone round the nail due to an irritative hyperemic decalcification would account for frequent failure . . . That there is some decalcification is undoubted, and the remarkable tightness of the nail when it is

first driven in is not maintained for more than a few weeks. After that time it is not difficult to slide the nail up and down in its socket in the bone."

Fig. 11. J. M., after Leadbetter reduction.

Fig. 12. J. M., anteroposterior view after reduction and insertion of Smith-Petersen nail.

Henderson[7] advocates the use of a lag screw and states: "The method was developed because in some instances the metal flanged nail became loose."

Hart[8] advocates fixing the Smith-Petersen nail by a wire threaded through the head of the nail and passed through a drill hole in the shaft of the femur.

Westcott[9] in reporting twelve cases in which the Smith-Petersen nail was used shows the *x*-ray prints, one of a case "after insertion of the nail and impaction of the fragments," and the other of the same case "two months later. Note firm bony union, shortening of neck and protrusion of nail head beyond cortex."

Harris[10] reports two cases in a series of fifty in which the nail which was accurately placed at the time of operation later protruded and the head was disengaged. The author ascribes this to early weight bearing.

Lippmann[11] uses a corkscrew bolt. In a report of eighteen cases he states: "It is true that after the tool-steel bolts have been in situ for some time, a small area of rarefaction appears about them. However, as the roentgenograms show, they do not change their position in the hip and healing has always been solid before the rarefaction is observed. There are no symptoms attributable to this rarefaction."

Godoy-Moreira[12] uses an ingenious stud-bolt screw which does not loosen or slip.

Venable and Stuck[13] state: "It is our observation that nails become loose (in the absence of infection or technical faults) because of electrolytic activity between the constituent metals in the alloy which is sufficiently intense to destroy adjacent bone. The amount of erosion we have found depends upon the constituents of the alloy and their resistance or relative passivity to electrolytic activity in the body fluids. Nickel or chromium-plated steel nails cause marked destruction of bone because of the galvanic cell action of the dissimilar metals. A single unplated nail of so-called

stainless steel is composed of many metals, such as iron, chromium, nickel, etc., and the electro-activity between them, which

Fig. 13. J. M., lateral view, shows nail not central, but in posterior half of head.

can be demonstrated with a microammeter, will cause bone to be corroded about the nail. Fluid accumulation which seems to indicate infection is more often a body reaction against the local irritation. Cultures of such fluid are invariably negative but chemical examinations usually reveal evidence of metals in solution."

The use of vitallium nails will undoubtedly diminish the incidence of extrusion; but if the composition of the nail is the sole cause of extrusion, it is difficult to explain why extrusion occurs in some nonvitallium nails and does not occur in others.

The following case reports illustrate these difficulties and they are presented in the hope of stimulating further effort to improve methods of fixation now at our disposal. We have recently been using the Austin Moore pins and although the immediate results are satisfactory, it is too early to evaluate the results.

CASE REPORTS

Case 1. S. M., a white male, age fifty-nine, was admitted to Cumberland Hospital on April 21, 1939, with an intracapsular midcervical fracture of the neck of the left femur. The fracture line was roughly transverse or at right angles to the long axis of the neck. (Fig. 1.) On April 27, 1939, an open operation was performed using an iliofemoral incision, reduction was effected and a Smith-Petersen nail inserted. (Figs. 2 and 3.) He left the hospital on June 30, 1939, and although several requests were addressed to him he failed to report to the follow-up clinic. On March 25, 1940, he returned to the hospital. He stated that on March 22, 1940, he experienced pain in the left hip and was unable to bear weight with the aid of crutches as he did formerly. *X*-rays taken on March 23, 1940, showed that the nail had been extruded and that he refractured the neck of his left femur. (Fig. 4.) On April 2, 1940, the nail was removed through a lateral incision, a McMurray osteotomy was performed and a plaster spica applied. (Fig. 5.) It was noted that the nail had practically no grip on the distal fragment and was very easily removed. What probably happened in this case was that nearly eleven months after the operation the nail was extruded from the head and because of inadequate union refracture occurred.

Case 11. F. P., a white female, aged fifty-one, was admitted to Cumberland Hospital on February 25, 1940, with an intracapsular midcervical fracture of the neck of the left femur. The line of fracture was oblique and ran from a point close to the head downward and outward so that very little of the neck was attached to the head along the upper border while about half an inch of the neck was attached to the head along the lower border. (Fig. 6.) She showed a four plus Wassermann reaction and gave a history of arrested pulmonary tuberculosis. On February 29, 1940, an open operation was performed using an iliofemoral incision and a Smith-Petersen nail was inserted. (Fig. 7.) After the operation, her lower extremity was placed in Russell traction. On March 9, 1940, her wound showed signs of an infection. Culture from the wound: anaerobic:

negative: aerobic; Staphylococcus pyogenes, but this was limited to the soft tissues. *X*-rays taken on April 3, 1940, (Fig. 8) showed that the nail was extruded from the head. On April 16, 1940, the nail was removed. It was found loose and it was noted that the infection was limited to the soft tissues. A Leadbetter reduction was performed and a plaster spica was applied. On May 4, she developed bronchopneumonia. Sulfapyridine was administered but she expired on May 9, 1940. At autopsy it was noted that the neck had been completely absorbed. A photograph of the specimen is shown in Figure 9. It was interesting to note that the neck had been completely absorbed in a period of thirty-six days or less. If absorption is due to hyperemic decalcification which in turn is caused by incomplete fixation and motion between the fragments, absorption must have occurred between the time that the nail was extruded and the patient's death. Absorption of the neck is a very important factor in causing nonunion. While a great deal of emphasis has been placed on aseptic necrosis of the head, absorption of the neck has not been sufficiently emphasized. A study of this phase is now being conducted and while it is too early to make any positive statement, the preliminary impression is that neck absorption may, in many cases, be a prelude to aseptic necrosis of the head.

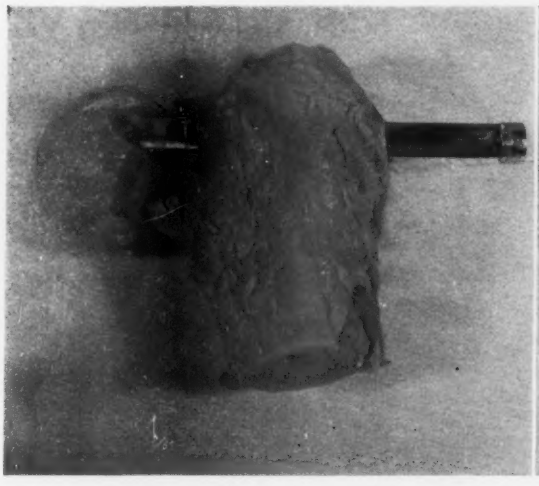

Fig. 14. J. M., specimen removed at autopsy shows little absorption of neck.

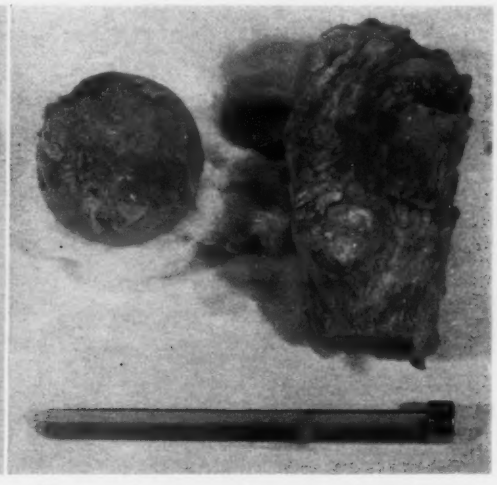

Fig. 15. J. M., another view of specimen removed at autopsy.

Case III. J. M., a white female, age seventy-five, sustained an intracapsular fracture of the neck of the left femur on February 27, 1940, (Fig. 10) and was admitted to Cumberland Hospital on the same day. She had some mucous rales in both bases and ran a low grade temperature; her left lower extremity was therefore placed in Russell traction. Her general condition improved and on March 19, 1940, under spinal anesthesia the fracture was reduced by the Leadbetter method and a valgus position of the head was obtained. (Fig. 11.) A lateral incision was made and a Steinman pin was drilled through the great trochanter into the head to anchor the fragments. A narrow, graduated Steinman pin was then drilled just below the site selected for driving the Smith-Petersen nail. This furnishes a valuable guide as to length and direction. A Smith-Petersen nail was then driven through and the fragments were impacted. *X*-rays showed that the nail passed through the neck and entered the head in its posterior half. (Figs. 12 and 13.) The patient had a smooth convalescence; her wound was clean and the sutures were removed on March 26, 1940. On April 1, 1940, she was permitted up in a chair. On April 6, she developed signs of pyelonephritis and cerebral thrombosis and expired on April 12, 1940. At autopsy it was noted that the fragments were in good alignment with the head in valgus position but there was some play between the head and the neck. After impacting the fragments during operation, it was noted that the head moved with the neck when the thigh was rotated. There was no evidence then of any play between the two fragments and it must be assumed that some loosening occurred during the period of twenty-four days between the operation and the patient's death. There was no absorption of the neck in this case as noted

in Case II. Figures 14 and 15 are photographs of the specimen.

COMMENT

It is not the writer's intention to condemn the Smith-Petersen nail as it has been found very useful in fixing fragments in many cases. However, it would be very desirable if among the data now being assembled on fractures of the neck of the femur, special attention were given to the various methods of internal fixation. It would further be very desirable if a central registry were established to which surgeons all over the country would be invited to report both their successes and their failures. The data thus assembled should provide a basis for a scientific and accurate evaluation and stimulate further research to develop an implement which will give complete fixation without the disadvantages of the implements now at our disposal.

SUMMARY

Three cases of extrusion of the Smith-Petersen nail are presented together with a review of the meager literature on the subject. It is hoped that similar reports from other surgeons may be forthcoming. In this way the mechanical difficulties attendant upon the use of a three-flanged nail can be properly evaluated and eventually eliminated.

A plea is made for a subclassification of intracapsular fractures of the neck of the femur based upon the position of the line of fracture, its inclination and the presence or absence of comminution. While internal fixation is applicable to the majority of intracapsular fractures, it is believed that there are certain fractures to which it is not applicable, and in which an osteotomy at the outset will save the patient much time and suffering. What this type of fracture is can be determined only by a critical analysis of large series of reports of both successes and failures.

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GALLBLADDER SURGERY*

A TEN YEARS' STATISTICAL REVIEW INCLUDING 410 OPERATED CASES

WILLIAM T. DORAN, M.D., F.A.C.S.,
Consulting Surgeon, Bellevue Hospital

KENNETH M. LEWIS, M.D., F.A.C.S.,
Associate Visiting Surgeon, Bellevue Hospital

EILIF C. HANSSEN, M.D., F.A.C.S.,
Assistant Visiting Surgeon, Bellevue Hospital

LESTER C. B. SPIER, M.D.
Assistant Visiting Surgeon, Bellevue Hospital

AND

WILLIAM T. DORAN, JR., M.D.
Assistant Visiting Surgeon, Bellevue Hospital

NEW YORK, NEW YORK

THE purpose of this paper is to review ten years' experience in gallbladder surgery on the Fourth Surgical Division of Bellevue Hospital. In 1933, 200 cases were reported. Since then, up to December 1938, 210 additional patients have been operated upon, making a total of 410 operated cases during the ten-year period. The cases were studied in a special gallbladder clinic which was established in 1928. If the history[1] and examination revealed an acute condition present, the patient was at once admitted to the hospital and further work-up done on the ward. Otherwise, the diagnostic work-up was continued in the Out-Patient Department and the patient was not sent into the hospital until his surgical status had been definitely established. A cholecystogram was ordered and the patient given an appointment for biliary drainage.

The cholecystograms are done by the oral dye method. Of the 200 operations reported from this clinic in 1933,[2] 126 had cholecystograms. The *x*-ray findings were correct in 72.2 per cent of these cases, as shown at operation. When no visualization of the gallbladder, delayed emptying or shadows of calculi were reported, the findings were confirmed in 80.4 per cent, while if cases showed normal visualization and normal emptying of the gallbladder without shadows of calculi, the *x*-ray findings were confirmed in but 44.8 per cent of the cases examined.

In our present series of 210 cases, cholecystograms were done in 147 cases with results as shown in Tables I and II. *X*-ray findings were confirmed at operation in 124 cases (84 per cent correct). In analyzing these findings from the standpoint of two main groups of cases, that is, those in which the gallbladder was seen and those in which the gallbladder was not seen or seen only faintly, delayed emptying or shadows of calculi, we note the following:

The *gallbladder was seen* and appeared normal in the *x*-ray in ten cases. In five of these cases stones were found at operation. *X*-ray findings were thus confirmed in 50 per cent of the cases.

The *gallbladder was not seen* or visualized only faintly, or showed shadows of calculi, or delayed emptying in 137 cases. One hundred nineteen cases showed stones at operation. The *x*-ray findings were thus confirmed in 87 per cent of the cases.

As pointed out in our first series of cases, the great margin of error lies in those cases which visualized normally by *x*-ray (50 per cent compared with 87 per cent in cases showing a pathological cholecystogram).

The enthusiastic endorsement of biliary drainage by Bochus[3] et al. in 1931 served as a great incentive in the performance of this technical procedure. These investiga-

* From the Gallbladder Clinic, Fourth Surgical Division, Bellevue Hospital, New York City.

tors at that time reported their biliary drainage findings in a series of 148 proved cases of cholelithiasis. They stated that in their experience, biliary drainage had proved superior to cholecystography in gallstone diagnosis. They emphasized that the presence of cholesterol crystals and calcium bilirubinate pigment in the same bile was pathognomic of gallstones. In 1933, Rousselot and Bauman[4] reported their results of an investigation of one hundred patients by duodenal drainage followed by operation. They stated that the finding of cholesterol crystals or bile pigment granules in diluted or concentrated bile almost certainly indicated the presence of gallstones. Rafsky,[5] in an analysis of sixty-nine patients operated upon and drained preoperatively by the duodenal tube, is quoted as follows:

Table I

X-ray and operative findings in 147 cases of present series, compared with series of 126 cases reported in 1933

	Operative Findings					
			1933	1939	1933	1939
	1933	1939	Stones	Stones	No Stones	No Stones
Number of cases *x*-rayed	126	147				
Gallbladder did not visualize	90	66	72	57	18	9
Gallbladder did visualize filled and emptied *normally* and did *not* show any shadows of stones	29	10	16	5	13	5
Gallbladder did visualize —and shadows suggestive of calculi were present	5	24	4	23	1	1
Gallbladder did visualize —but showed delayed emptying	2	5	1	4	1	1
Gallbladder visualized faintly	...	26	...	19	..	7
Gallbladder did not visualize shadows of calculi present	...	16	...	16		
Total	126	147	93	124	33	23

"In evaluating the diagnostic importance of the crystalline elements in preoperative specimens of bile, one point should always be borne in mind, namely, the number of crystals seen and the amount of pigment observed in the bile. A few scattered crystals, or a small amount of calcium bilirubinate pigment, has not much significance diagnostically, but numerous cholesterol crystals and a large amount of calcium bilirubinate pigment, separately or together in bile preoperatively, does indicate in most instances a calculous or non-calculous cholecystitis."

Table II

Diagnostic accuracy of cholecystography

	Number of Cases		Stones at Operation		*X*-ray Confirmed, Per Cent	
	1933	1939	1933	1939	1933	1939
Gallbladder not visualized, or visualized faintly, or visualized but showed shadows of calculi, or delayed emptying	97	137	78	119	80	87
Gallbladder did visualize and appeared normal in *x*-rays	29	10	16	5	44.8	50
Total cases	126	147				

Of Rafsky's sixty-nine cases reported, which showed crystals prior to operation, fifty-nine had stones at operation, twelve had chronic cholecystitis and six showed a normal gallbladder. Carter, Green and Twiss,[6] stress the value of biliary drainage as a diagnostic measure in cases of biliary stasis. However, they disagree with those who claim that the presence of crystals in the bile is pathognomic of gallstones. Quoting these authors: "The presence of crystals has been described as indicative of the presence of stones. That this is a misleading conclusion is apparent when the operative findings in this series of 239 cases are compared with the duodenal

drainage findings. In 24.4 per cent of the patients with stones, no crystals were found in the preoperative duodenal drainage, while they were present in 82.6 per cent of the cases without stones. While the presence or absence of crystals has no specific diagnostic import where stones are concerned, they are definitely indicative of stasis in the biliary tract. This is particularly evident in patients presenting dyskinesia of the gallbladder who frequently show an exacerbation of their symptoms at the same time that the duodenal drainage shows the presence of crystals."

In 1933, our[2] preoperative drainage findings in a series of fifty-six patients operated upon resulted in our stating that the presence of cholesterol crystals or calcium bilirubinate pigment, or both, in biliary drainage bile was usually associated with cholelithiasis. However, in 1938, after five years of further experience with this method of diagnosis, our attitude toward the diagnostic significance of crystals changed. At that time Doran, Forster and Spier[7] analyzed sixty-four, cases in which operation was performed and the patients drained preoperatively, and concluded that the finding of crystals in the bile was not pathognomic of stones but was evidence of pathology in the biliary tract.

Our technic of duodenal drainage of the biliary system is essentially the same as originally described by Lyon[8] in 1919. We believe, however, that certain mechanical improvements in this technic today render the test more successful, more accurate and more understandable.

TABLE III

CORRELATION OF MICROSCOPIC DUODENAL DRAINAGE FINDINGS AT OPERATION IN 209 OPERATED CASES

Microscopic Findings			Calculi Gallbladder, Cases	Calculi Cystic Duct, Cases	Calculi G.B. and Common Duct, Cases	Calculi G.B. and Cystic Duct, Cases	Calculi G.B., Common Duct and Cystic Duct, Cases	Positive for Calculi		Negative for Calculi, Cases
	Cases	Per Cent						Cases	Per Cent	
Cholesterol	50	24	38	2	2	4	0	46	92	4
Calcium bilirubinate	34	16	20	1	1	5	0	27	79.4	7
Cholesterol and calcium bilirubinate	36	17	26	0	1	1	0	28	77	8
Pus	3	1	2	0	0	0	1	3	....	0
Blood	1	.5	1	0	0	0	0	1	....	0
Negative	85	40	43	1	0	3	1	48	58	36

The first of these mechanical aids is the Twiss tube;[9] second, is the horizontal tilt table fluoroscope. For the past year and a half we have been using this type of table in our clinic. Prior to this time we had done 1,062 drainages in this Clinic with 198 or 18.6 per cent unsuccessful. Since the installation of this equipment, we have done 248 drainages of which only fourteen have been unsuccessful, a percentage of 5.6, thus reducing our total for 1,310 drainages to 16.1 per cent.

TABLE IV
SEX

	First Series 200 Cases	Second Series 210 Cases
Females	161, or 80.5%	163, or 77.6%
Males	39, or 19.5%	47, or 22.4%

The technic of nonsurgical biliary drainage on the tilt table fluoroscope is comparatively simple. The tube is ingested with the patient in the erect position, and then with

careful, short exposures, the tube is visualized entering the cardiac orifice of the stomach and progressing along the greater curvature toward the pylorus. The table is then tilted backward toward the horizontal position. This maneuver causes the greater curvature to rise from approximately the level of the crests of the ilium to the level of the last dorsal vertebra, and the bucket of the tube is then either at the pyloric orifice or just past it. Any excess of tube is then retracted. With the hand that is shielded by a lead glove, the stomach is elevated by pressure on the greater curvature and the tube is directed through the pylorus and into the duodenum.

TABLE V
AGE

	First Series 200 Cases	Second Series 210 Cases
Average	41	46.2
Youngest	20	20
Oldest	70	78

In the passage through the stomach, the gastric contents are aspirated, first, to hasten the passage to the duodenum, and second, to determine the presence or absence of free hydrochloric acid. This is hastily, though roughly, accomplished by means of the indicator, nitrazene. A notation is then made on the chart for the benefit of clinical therapy and diagnosis. In those cases that present difficulty in manipulating the tube through the pylorus, the stomach is filled with warm saline or sometimes with plain water. In certain cases, especially when the patient is excitable and gags frequently, the tube will not pass through the pyloric orifice because the hand on the abdominal wall is not sufficient to control the spasm of the stomach when stimulated by gag reflex. Distended with warm water the stomach is more easily manipulated. When the tube has passed through the pylorus and the first portion of the duodenum, the patient is rotated over to the right side. When in this position, the second portion of the duodenum is the most dependent portion and becomes the limbus of a U-tube that holds between 30 and 50 cc.

With the bucket of the tube in the second portion of the duodenum, the duodenal contents are aspirated, and one ounce of a 25 per cent solution of magnesium sulphate is instilled. The tube is clamped off for five minutes, then reopened to drain as a syphon. The following notes are made: First, the presence or absence of bile; second, is the initial flow of golden yellow bile followed by a flow of concentrated bile without any further stimulation?

In the original communication of Meltzer he contended that relaxation of the sphincter of Oddi[2] would lead to the evacuation of the gallbladder, according to the law of contrary innervation of sphincters. At that time, it was believed that when the sphincter relaxed, the gallbladder contracted. Recent physiological investigation fails to substantiate this hypothesis. It is, however, an established physiological fact that when the gallbladder contracts, the sphincter relaxes.

We believe that magnesium sulphate acts on the sphincter of Oddi as a local anesthetic agent, and that the relaxation of the sphincter by magnesium sulphate results in a flow of common duct bile. It has no direct effect upon the gallbladder itself. In some instances there is a flow of concentrated bile following the relaxation of the sphincter. This is neither expected nor normal, although it happens not infrequently in any group of patients with gallbladder disease.

After releasing the clamp following the injection of the magnesium sulphate, 30 cc. of golden yellow (light) bile are collected. In those cases in which concentrated (dark) bile proceeds to flow spontaneously, we wait until the flow of dark bile ceases and the light bile is again running freely. Then we instill one ounce of olive oil through the tube and again clamp it off for from five to ten minutes. When the tube is released we collect the bile specimen and note the

presence or absence of concentrated bile. In those cases in which a rather large amount of concentrated bile flows following the introduction of magnesium sulphate, the stimulation obtained by the olive oil may result in a further flow of concentrated bile. This should be carefully noted.

Examination is then made microscopically without the use of stain or fixation. This examination is for the presence or absence of cholesterol crystals and calcium bilirubinate. Cholesterol crystals appear as four sided figures with one corner punched off. They may be the extreme of a rectangle or almost as equally sided as squares, but there is always one corner broken off squarely. They are colorless and, even in the most concentrated bile, remain so. Calcium bilirubinate can be seen in the same way, at the same time and its presence is indicative of biliary pathology. It usually appears in an amorphous form, translucent and orange colored, but may appear as red granules.

We have performed 1,310 nonsurgical biliary drainages on 491 patients (1.3.). One patient has been drained twenty times over a period of five years, and a second patient has been drained ten times over a three-year period. Except for these two patients, the procedure has been limited to one or two diagnostic drainages in patients upon whom surgery has been performed. Postoperative drainages have been used routinely to determine the function of the sphincter of Oddi and the presence or absence of bile or crystals.

Of the 491 patients drained, 209 were operated upon. It must be remembered that all of these patients were referred to this Clinic by either general medical or general surgical clinics with the provisional diagnosis of gallbaldder disease. Of the 491 patients on whom drainages were performed, operation was recommended in 236, or 48 per cent. Of these, twenty-seven refused operation or preferred to have their surgery performed elsewhere by private surgeons, leaving a total number of 209 cases, or 42.6 per cent operated upon. Of these 209 in which biliary drainage was performed, three cases were found to be negative at operation for biliary pathology, or 1.4 per cent. Of the remaining 255 patients, 214 were treated medically for disease of the biliary system and forty-one were referred to other clinics for treatment.

Of the 209 patients who were drained preoperatively, 113, (54 per cent) showed concentrated bile in varying amounts. Of these cases, calculi were found in seventy-eight (69 per cent). Ninety-six (46 per cent) did not show concentrated bile at the preoperative drainage, and of these cases sixty-nine (72 per cent) were found to possess calculi. It is, therefore, our belief that the presence or absence of concentrated bile in the preoperative drainage, bears no direct relationship to the presence or absence of calculi found at the time of operation. It is also our belief that in regard to the gallbladder, the presence of concentrated bile denotes only patency of the cystic duct and gallbladder function in terms of the ability of the viscus to concentrate bile.

In 120 of the 209 cases, either cholesterol crystals or bilirubin calcium pigment or both of these were present. Table III shows a correlation between microscopic findings in biliary drainage and findings at operation in 209 cases. Fifty cases showed cholesterol crystals in the bile prior to operation. Stones were found in forty-six cases (92 per cent). Thirty-four cases showed bilirubin calcium in the preoperative bile. Stones were present at operation in twenty-seven cases (79.5 per cent). Both cholesterol crystals and bilirubin calcium pigment were found in thirty-six cases. Stones were present at operation in twenty-eight of these cases (77.8 per cent). In eight-five cases no crystals were seen in the bile obtained by duodenal drainage. Calculi were found in forty-nine cases (57.6 per cent).

These findings indicate that when cholesterol crystals or bilirubin calcium pigment are found in bile obtained by duodenal

drainage prior to operation, there is a strong probability that stones are present. However, the absence of cholesterol crystals or bilirubin calcium pigment is not a reliable indicater of the absence of stones.

We appreciate well that nonsurgical biliary drainage has both its proponents and opponents, but we regard it as a necessary and important link in the diagnostic chain. We do not believe that it supplants the *x*-ray or the cholecystogram; we do not hold that it is the pathognomic test of biliary tract disease; but we definitely believe that in our hands it has been a valuable adjunct in the diagnosis of biliary pathology. In our studies relative to determining those cases that should be treated medically, we are of the opinion that it is most important. We have operated upon only 42 per cent of our gallbladder patients with a resultant decrease in both our mortality and morbidity statistics.

Nonsurgical biliary drainage has been utilized in our Clinic postoperatively as a means of determining the function of the sphincter of Oddi and as an aid in its management. It is our belief that much of the postoperative morbidity following operation on the gallbladder is due to spasm of the muscle of the sphincter of Oddi. It has been our experience that in the absence of any concomitant disease such as ulcerative colitis, chronic appendicitis and the various hypertonic states, that biliary drainage is a valuable adjunct. We believe that it is but one part of postoperative management and that without dietary regulation, general hygienic measures and the judicious use of sedatives and antispasmodics, it cannot stand alone. We do hold, however, that the common and hepatic ducts not infrequently are the sites of origin of very definite pathology including the formation of calculi. We further believe that operative interference destroys temporarily the continuity of the hepatobiliary system, and that postoperative management of all gallbladder patients is as essential in the eventual morbidity of any given series as is the preoperative treatment and the operative technic.

If the history, physical findings, cholecystogram and drainage findings indicate the presence of gallbladder disease, the patient is admitted to the hospital ward. Here the following further work-up is given while preparation for the operation proceeds: icteric index, blood cholesterol, blood sugar, nonprotein nitrogen, bleeding time, clotting time, Van den Bergh test, bile in urine, blood Wassermann, urinalysis, complete blood count. At operation cultures are made of the gallbladder wall and gallbladder bile whenever possible.[6] Following discharge from the ward, the patient is referred to the gallbladder clinic where the patient is seen at weekly intervals until well, and then at longer periods. Periodic gallbladder drainages are done to ascertain the character of the bile. Diets and medications are prescribed, including sedatives and antispasmodics as indicated.

Our routine operative and postoperative treatment is outlined elsewhere.[2] During the past two years we have discontinued our past practice of using spinal anesthesia routinely. We insert T-tubes whenever the common duct has been opened and when indicated take a cholangiogram to determine the presence of any calculi which have been overlooked in the common duct. In jaundice cases with prolonged clotting time, we give vitamin K and bile salts supplemented by blood transfusions if necessary. We routinely use catgut for sutures and ligatures. Recently we have used both silk and cotton thread in place of catgut.

The following statistical study is based on 410 patients with benign biliary tract disease, operated upon on the wards of the Fourth Surgical Division of Bellevue Hospital during the past ten years. It includes the present series of 210 cases and 200 cases reported previously. It does not include those cases in which operation revealed a normal gallbladder, malignancy or pathology of adjacent organs.

Of the present series of 210 cases, 163 or 77.6 per cent were females, and forty-

seven or 22.5 per cent were males (Table IV). The ages ranged from twenty to seventy-eight years, the average being 46.2 years (Table V).

There were 127 (60.5 per cent) cases of chronic cholecystitis with stones, twenty-six (12.4 per cent) cases of chronic cholecystitis without stones, thirty-three (15.7 per cent) cases of acute cholecystitis with stones, ten (4.8 per cent) cases of acute cholecystitis without stones, and fourteen (6.7 per cent) cases of stones in the common duct. Each of these groups will be analyzed separately.

CHRONIC CHOLECYSTITIS WITH STONES—127 CASES

History. The average age was forty-three years, the youngest was twenty-one, the oldest seventy-two years. There were twenty males (15.7 per cent) and one hundred and seven females (84.3 per cent). The chief complaint was pain in 125 cases. The duration of attacks of pain varied from two hours to eighteen years. Seven (5.6 per cent) patients had had previous cholecystostomy; three (3.4 per cent) had had typhoid fever. In ninety-two (73.8 per cent) cases the pain was localized in the right upper quadrant and in forty-three (34.4 per cent) cases in the epigastrium. The pain was colicky in one hundred (80 per cent) patients, dull aching in fourteen (11.2 per cent); radiated to the back in ninety-five (76 per cent) and to the right shoulder in sixty-one (48.8 per cent); it was aggravated by food in thirty-three (26.4 per cent) and by fats in twenty-nine (23.2 per cent). The pain required a hyperdermic of morphine sulphate in twenty-three (18.4 per cent) cases. The associated symptoms were as follows: Nausea, ninety-seven (76.4 per cent) cases; vomiting, eighty-eight (69.3 per cent); belching, ninety-seven (76.4 per cent); distention, 101 (79.5 per cent), persistent jaundice, nine (7.1 per cent); transient jaundice, twenty (15.7 per cent); clay colored stools, seventeen (13.4 per cent); fever, twenty-nine (22.8 per cent); chills, twenty-nine (22.8 per cent). Loss of weight occurred in fifty-seven (44.9 per cent) cases; average loss nineteen pounds; loss of thirty pounds or more in fifteen (11.8 per cent) cases; lowest loss four pounds, greatest loss fifty pounds.

Physical Examination. The temperature was normal in eighty-three (66.9 per cent) cases and elevated in forty-one (33.1 per cent). The pulse was under ninety in eighty-five (70.8 per cent) cases and over ninety in thirty-five (29.2 per cent); seventy-five (82.5 per cent) patients were obese, thirty-nine (32.5 per cent) were average; three (2.5 per cent) were emaciated; jaundice was present in fourteen out of 108 (13.0 per cent) cases. Tenderness was present in the right upper quadrant in ninety-six (75.6 per cent) cases, rigidity in twenty-nine (22.8 per cent) and mass in nineteen (15.0 per cent).

Laboratory Tests. The average white cell count in ninety-three cases was 11,400, polys 73 per cent, blood cholesterol was done in sixty-six cases; the average was 163, lowest ninety-three, and highest 307. Icteric index was taken in seventy-five cases; average was 9.8, lowest two, and highest seventy. Direct Van den Bergh was positive in fourteen out of sixty-six (24.2 per cent) cases. The average blood sugar in seventy-eight cases was 105. The average blood urea in eighty-four cases was 15.5. The average bleeding time in fifty-four cases was 2.5 minutes, coagulation time 4.1 minutes.

Operative Procedure. Cholecystectomy was performed in 127 cases. Findings: Gallstones in gallbladder in all cases. Pathological reports: chronic cholecystitis 115 (90.6 per cent) cases, cholesterosis of gallbladder, eight (6.3 per cent), no report in four cases. Deaths: three cases (2.4 per cent). Cause of death: (1) Pulmonary embolus, sixteen days postoperatively (autopsy); (2) death on first postoperative day, cause unknown (no autopsy); (3) bile peritonitis due to injury to right hepatic duct; died twenty-five days postoperatively (autopsy).

CHRONIC CHOLECYSTITIS WITHOUT STONES—TWENTY-SIX CASES

History. The average age was forty-one years. The youngest was twenty-seven, the oldest sixty-four years. There were five (19.2 per cent) males and twenty-one (80.8 per cent) females. The chief complaint was pain in every case. The duration of attacks of pain varied from four days to twenty-five years. One (3.8 per cent) patient had had a previous cholecystostomy; none had had typhoid fever. The pain was localized in the right upper quadrant in eighteen (69.2 per cent) cases and in the epigastrium in sixteen (61.5 per cent) cases. It was colicky in character in eight (30.8 per cent) cases and dull aching in eight (30.8 per cent) cases; it radiated to the back in seventeen (65.4 per cent) cases and to the right shoulder in eleven (42.1 per cent) cases; it was aggravated by food in eight (30.8 per cent) cases and by fats in five (19.2 per cent) cases. In only one (3.8 per cent) case was a hyperdermic of morphine sulphate required for relief. Associated symptoms were as follows: nausea in twenty-one (80.8 per cent) cases, vomiting in twenty-two (84.6 per cent) cases, belching in twenty (76.9 per cent) cases, distention in eighteen (69.2 per cent) cases, transient jaundice in five (19.2 per cent) cases, clay colored stools in two (7.8 per cent) cases, fever in seven (26.9 per cent) cases, chills in six (23.1 per cent) cases, loss of weight occurred in ten (38.5 per cent) cases; the average loss was twenty-six pounds, the lowest loss was four pounds, the greatest loss forty pounds.

Physical Examination. The temperature was normal in nineteen (86.4 per cent) cases and elevated in three (13.7 per cent) cases. The pulse was under 90 in fourteen (63.7 per cent) cases and over 90 in eight (36.3 per cent) cases.

Thirteen (59.1 per cent) patients were obese, eight (36.7 per cent) cases average and one (4.5 per cent) emaciated. Jaundice was present in two out of twenty-two (9.0 per cent) cases. There was tenderness in the right upper quadrant in twenty (76.9 per cent) cases, and rigidity in four (15.4 per cent) cases.

Laboratory Tests. Average white cell count was 9,100, and polys 70 per cent. The average blood cholesterol in sixteen cases was 154, the lowest was ninety, and the highest 211. The icteric index in seventeen cases was 7.9 per cent, the lowest was two, and the highest forty. The direct Van den Bergh test was positive in three out of eighteen (16.5 per cent) cases. The indirect Van den Bergh test was positive in four out of eighteen (22.2 per cent) cases. The blood sugar average in eighteen cases was 101. The average blood urea in nineteen cases was sixteen. The average bleeding time in ten cases was 2.4 minutes and the coagulation time four minutes.

Operative Procedure. Cholecystectomy was performed in every case; choledochostomy in one. Findings: Chronic cholecystitis without stones in all cases. Pathological reports: Chronic cholecystitis in twenty-two (84.6 per cent) cases, cholesterosis of gallbladder in three (11.5 per cent) cases. No report in one case. Deaths: One case (3.8 per cent). Cause of death: liver death, patient died twenty-four hours postoperatively, temperature 107° (no autopsy).

ACUTE CHOLECYSTITIS WITH STONES—THIRTY-THREE CASES

History. The average age was fifty years, the youngest was twenty-five, the oldest seventy-eight years. There were fourteen males (42.4 per cent) and nineteen (57.6 per cent) females. The chief complaint was pain in thirty-one cases. The duration varied from four hours to three years. In one (3.2 per cent) case cholecystostomy had already been performed. There was no history of typhoid fever. The pain was localized in the right upper quadrant in twenty-six (83.9 per cent) cases and in the epigastrium in nine (29.0 per cent) cases. It was colicky in character in fifteen (48.4 per cent) cases and dull aching in ten (32.2 per cent) cases. It radiated to the back in sixteen

(51.6 per cent) cases, and to the right shoulder in thirteen (41.9 per cent) cases; it was aggravated by food in five (16.1 per cent) cases and by fats in one (3.3 per cent) case. The pain required a hyperdermic of morphine sulphate in three (9.7 per cent) cases. The associated symptoms were as follows: nausea in twenty-six (78.8 per cent) cases, vomiting in twenty-four (72.7 per cent) cases, belching in twenty (60.6 per cent) cases, distention in twenty (60.6 per cent) cases, persistent jaundice in one (3.0 per cent) case, fever in fifteen (45.5 per cent) cases, chills in fifteen (45.5 per cent) cases. Loss of weight occurred in nine (27.4 per cent) cases; the average loss was twenty-four pounds. In two (6.0 per cent) cases the loss was thirty pounds or more. The greatest weight loss was sixty pounds.

Physical Examination. The temperature was normal in four (12.1 per cent) cases and elevated in twenty-nine (87.9 per cent) cases. The pulse was under 90 in eleven (34.4 per cent) cases and over 90 in twenty-one (65.6 per cent) cases. Twelve (40 per cent) patients were obese and seventeen (56.7 per cent) were average. Jaundice was present in five out of ten (50 per cent) cases. Tenderness in the right upper quadrant was present in thirty (9.9 per cent) cases, rigidity in nineteen (57.6 per cent) cases and mass in ten (30.3 per cent) cases.

Laboratory Reports. The average white cell count was 15,700, polys 84 per cent. The blood cholesterol in seventeen cases averaged 158, lowest 125, highest 267. Icteric index in twenty cases averaged 11.6, lowest two, highest thirty. The direct Van den Bergh test was positive in four out of twenty-two (18.2 per cent) cases. The indirect Van den Bergh test was positive in six out of twenty-two (27.3 per cent) cases. The average blood sugar was 109 in nineteen cases. The average blood urea was 16.5 in twenty-three cases, lowest twelve, highest twenty-two. Bleeding time was 3.2 minutes.

Operative Procedure. Cholecystectomy was performed in twenty-six (78.8 per cent) cases; cholecystostomy in seven (21.2 per cent). Findings: acute cholecystitis with stones in gallbladder in all cases. Pathological reports: Acute cholecystitis in twenty-six (78.8 per cent) cases; no reports in seven cases. Deaths: Three cases (9.1 per cent). Cause of death: (1) Fourth postoperative day; cause uncertain (no autopsy); (2) peritonitis sixth postoperative day (no autopsy); (3) cardiac failure first post-operative day (no autopsy).

ACUTE CHOLECYSTITIS WITHOUT STONES—TEN CASES

History. The average was forty-six years, the youngest was twenty, the oldest seventy-two years. There were five (50 per cent) males and five (50 per cent) females. The chief complaint was pain in nine cases. The duration of attacks of pain varied from two days to ten years. Cholecystostomy had been performed in one case. In one (10 per cent) case there was a history of typhoid fever. The pain was localized in the right upper quadrant in five (55.6 per cent) cases, and in the epigastrium in six (66.7 per cent) cases. The pain was colicky in character in six (66.7 per cent) cases and dull aching in two (22.2 per cent) cases; it radiated to the back in five (55.0 per cent) cases and to the right shoulder in three (33.3 per cent) cases; it was aggravated by food in four (44.4 per cent) cases and by fats in two (22.2 per cent) cases. In no case was a hyperdermic of morphine sulphate used for relief. The associated symptoms were as follows: nausea in eight (80 per cent) cases, vomiting in eight (80 per cent) cases, belching in seven (70 per cent) cases, distention in six (60 per cent) cases, persistent jaundice in two (20 per cent) cases, transient jaundice in no cases, clay colored stools in no cases, fever in six (60 per cent) cases, chills in five (50 per cent) cases. There was loss of weight in four (40 per cent) cases; the average loss was twelve pounds, and the greatest loss was twenty-five pounds.

Physical Examination. The temperature was normal in two (20 per cent) cases and elevated in eight (80 per cent) cases. The pulse was under 90 in five (50 per cent) cases and over 90 in five (50 per cent) cases; six (60 per cent) patients were obese, three (30 per cent) were average. Jaundice was present in two out of five (40 per cent) cases. There was tenderness in the right upper quadrant in eight (80 per cent) cases, rigidity in seven (70 per cent) cases and a mass in two (20 per cent) cases.

Laboratory Reports. The average white cell count was 12,500, polys 80 per cent. The average blood cholesterol in three cases was 150, the lowest was 130 and the highest was 160. The average icteric index in four cases was 26.5, the lowest was three and the highest was ninety. The direct Van den Bergh test was positive in two out of five (40 per cent) cases. The indirect Van den Bergh test was positive in two out of five (40 per cent) cases. The blood sugar averaged 133 in five cases. The blood urea in six cases averaged sixteen, the lowest thirteen and the highest eighteen. The bleeding time in five cases averaged 2.2 minutes and the coagulation time 4.2 minutes.

Operative Procedure. Cholecystectomy was performed in four (40 per cent) cases, cholecystostomy in six (60 per cent) cases. Findings: Acute cholecystitis without stones in all cases. Pathological reports: Acute cholecystitis in five (50 per cent) cases. No report in five cases, gallbladder not having been removed at the time of operation. Deaths: None. In two of these cases gallstones were found in the gallbladder at a subsequent operation. In another case in which the gallbladder had perforated directly into the peritoneal cavity, the stone or stones may have escaped through the perforation.

STONES IN COMMON DUCT—FOURTEEN CASES

History. The average age was fifty-one years, the youngest was thirty years and the oldest was sixty-seven years. There were three (21.4 per cent) males and eleven (78.6 per cent) females. The chief complaint was pain in fourteen cases. The duration of symptoms varied from one day to twenty years. There was no history of typhoid fever. The past history revealed cholecystostomy in one (7.1 per cent) case and choledochostomy in one (7.1 per cent) case. The pain was localized in the right upper quadrant in seven (50 per cent) cases and in the epigastrium in seven (50 per cent) cases. The pain was colicky in character in ten (71.4 per cent) cases and dull aching in three (21.4 per cent) cases, radiated to the back in nine (64.3 per cent) cases and to the right shoulder in three (21.4 per cent) cases; it was aggravated by food in two (14.3 per cent) cases and by fats in two (14.3 per cent) cases. The pain was relieved by a hyperdermic of morphine sulphate in two (14.3 per cent) cases. The associated symptoms were as follows: nausea in eleven (78.6 per cent) cases, vomiting in ten (71.4 per cent) cases, belching in ten (71.4 per cent) cases, distention in ten (71.4 per cent) cases. There was persistent jaundice in four (28.6 per cent) cases, transient jaundice in six (42.9 per cent) cases, clay colored stools in seven (50 per cent) cases, fever in eight (57.1 per cent) cases, chills in eight (57.1 per cent) cases. There was a loss of weight in ten (71.4 per cent) cases. The average loss was twenty-four pounds. A loss of thirty pounds or more occurred in two (13.3 per cent) cases, the greatest loss being fifty pounds.

Physical Examination. The temperature was normal in four (28.6 per cent) cases, and elevated in ten (71.4 per cent). The pulse was under 90 in six (42.9 per cent) cases and over ninety in eight (57.1 per cent) cases. Six (50 per cent) patients were obese and four (33.3 per cent) cases average. Jaundice was present in eight out of nine (88.9 per cent) cases. There was tenderness in the right upper quadrant in seven (50 per cent) cases, rigidity in five (21.4 per cent) cases and a mass in one (7.1 per cent) case.

Laboratory Reports. The average white cell count in thirteen cases was 10,500

polys, 81 per cent. The average blood cholesterol in ten cases was 175, lowest 140 and the highest 267. The average icteric index in twelve cases was thirty-nine, lowest five and highest ninety. The direct Van den Bergh test was positive in nine out of eleven (81.8 per cent) cases. The blood sugar in twelve cases averaged 109. The blood urea in thirteen cases averaged 16.8, lowest twelve and the highest twenty-eight. The bleeding time in eight cases averaged 2.1 minutes and the coagulation time was 5.3 minutes. Blood Wassermanns were taken in thirteen cases and found to be negative.

Table VI
OPERATIVE PROCEDURES IN 410 CASES OF BILIARY TRACT DISEASE

	Cholecystectomy	Cholecystostomy	Choledochostomy
Chronic cholecystitis with stones	127	..	1
Chronic cholecystitis without stones	26	..	1
Acute cholecystitis with stones	26	7	
Acute cholecystitis without stones	4	6	
Stones in common duct	8	2	14
Total (1939 series)	191	15	15
Total (1933 series)	190	10	7
Combined total	381	25	22

Operative Procedure. Cholecystectomy in eight (57.1 per cent) cases, cholecystostomy in two (14.2 per cent) cases and choledochostomy in fourteen (100 per cent) cases. Findings: Stones in common duct in every case. Chronic cholecystitis with stones in seven (50 per cent) cases and acute cholecystitis with stones in one (7.1 per cent). Pathological reports: Chronic cholecystitis with stones in seven (50 per cent) cases; acute exudative cholecystitis with stones in one (7.1 per cent) case. Deaths: Five deaths (35.7 per cent). Cause of death: (1) Peritonitis, sixth postoperative day (no autopsy); (2) pulmonary embolus, fourth week postoperatively (no autopsy); (3) liver death, twenty-four hour postoperatively (no autopsy); (4) cardiac failure, second postoperative day (no autopsy); (5) collapse of lung, bilateral pleurisy, septic splenitis, biliary nephrosis, fourth postoperative day (autopsy).

Table VII
OPERATIVE FINDINGS IN 410 CASES OF BILIARY DISEASE
Operative Findings Compared with Series Previously Reported Are Presented in Table VII

	1933 Cases	1939 Cases
Chronic cholecystitis with stones	124	127
Chronic cholecystitis without stones	51	26
Acute cholecystitis with stones	21	33
Acute cholecystitis without stones	4	10
Stone in common duct	*	14
Total	200	210

* In the 1933 series of 200 cases the common duct was opened seven times to remove calculi.

The operative procedures are recorded in Table VI and operative findings in Table VII.

Table VIIIA
BACTERIOLOGIC CULTURES FROM GALLBLADDER WALL IN 60 BILIARY TRACT CASES

	Total Cases	Positive Cultures	No Growth
Acute cholecystitis without stones	2	0	2
Acute cholecystitis with stones	8	7	1
Total	10	7	3
Chronic cholecystitis without stones	8	3	5
Chronic cholecystitis with stones	42	23	19
Total	50	26	24
Grand total	60	33	27

Table VIII shows the bacteriological findings in sixty cases in which cultures were taken from gallbladder wall at the time of operation. Positive cultures occurred in thirty-three out of sixty (55 per cent) cases. The organisms most

frequently found in the gallbladder wall in sixty operated cases were Bacillus coli (42 per cent) Staphylococcus aureus, (24 per cent), gram-negative bacillus and Staphylococcus aureus (12 per cent), Streptococcus viridans (6 per cent), Staphylococcus aureus and Streptococcus viridans (6 per cent).

TABLE VIIIB
BACTERIOLOGIC CULTURES FROM THE GALLBLADDER WALL IN 60 BILIARY TRACT CASES

Variety of Bacteria Cultured	Acute Cholecystitis	Chronic Cholecystitis	Totals, Per Cent
B. Coli	4	10	14 (42)
Str. viridans	1	1	2 (6)
Staph. aureus	2	6	8 (24)
Staph. aureus and gram negative bacillus	..	4	4 (12)
Staph. aureus and str. viridans	..	2	2 (6)
Gram-positive bacillus	..	1	1
Diphtheroids	..	2	2
B. typhosus	..	0	0

Table IX shows bacteriological findings in ninety-six cases in which cultures were made from the fluid contents of gallbladders removed at operation. Positive cultures occurred in forty-nine out of ninety-six cases (51 per cent). Staphylococcus aureus occurred in 27 per cent of the positive cultures, Bacillus coli in 22 per cent, and Streptococcus viridans in 14 per cent.

TABLE IXA
BACTERIOLOGIC CULTURES FROM FLUID CONTENTS OF GALLBLADDER IN 96 BILIARY TRACT CASES

	Total Cases	Positive Cultures	No Growth
Acute cholecystitis without stones	6	4	2
Acute cholecystitis with stones	11	9	2
Total	17	13	4
Chronic cholecystitis without stones	12	5	7
Chronic cholecystitis with stones	67	31	36
Total	79	36	43
Grand total	96	49	47

TABLE IXB
BACTERIOLOGIC CULTURES FROM FLUID CONTENTS OF GALLBLADDER IN 96 BILIARY TRACT CASES

Variety of Bacteria Cultured	Acute Cholecystitis	Chronic Cholecystitis	Totals
B. coli	3	8	11 (22%)
Str. viridans	3	4	7 (14%)
Str. viridans and B. coli	1	..	1
Str. viridans and gram positive bacillus	..	1	1
B. Welchii	1	..	1
Staph. aureus	3	10	13 (27%)
Staph. aureus and str. viridans	..	2	2
Staph. aureus and str. non-hemolyticus	..	1	1
Staph. aureus and B. Coli	1	..	1
Staph. aureus and gram positive bacillus	..	1	1
Staph. aureus and gram negative bacillus	..	2	2
Staph. aureus and diphtheroids	1	..	1
B. subtilis	..	1	1
Diphtheroids	..	2	2
Gram-positive bacillus	..	2	2
Indifferent str	..	1	1
B. Morgagni	..	1	1
B. typhosus	0	0	0

Complications (Table x) occurred in ninety-three cases out of the series of 410 operated cases. The most frequent complication was wound infection which occurred in thirty-four (8 per cent) cases, Pneumonia occurred in eleven cases, cardiac decompensation in eight cases and postoperative shock in five.

Of the 410 patients operated upon, twenty-six died, a mortality rate of 6.3 per cent. If cases of acute cholecystitis and common duct stone are excluded, the mortality rate in the recent series of 210 cases becomes 2.6 per cent. The causes of death are listed in Table XI.

FOLLOW-UP RESULTS

Of the 410 cases operated upon in which gallbladder pathology was found, there

were twenty-six deaths, leaving 384 cases to be followed. We have followed 222 (58 per cent) cases for periods ranging from six months to five years, except twenty-one cases which were followed for only three months. In the follow-up study we inquired as regards right upper quadrant pain, dull aching in character, or colicky; radiating to the back or right shoulder. We grouped under indigestion the symptoms of nausea, vomiting, belching and distention. Any recurrence of jaundice was also recorded.

TABLE X
POSTOPERATIVE COMPLICATIONS IN 410 CASES OF BILIARY TRACT DISEASE

	1933 Cases	1939 Cases
Hemorrhage	1	
Pneumonia	5	6
Dehiscence of wound	3	2
Phlebitis	1	1
Massive collapse of lung	1	
Bile sinus, 21 days	1	
Pulmonary embolus	3	2
Wound infection	11	23
Cardiac decompensation	2	6
Dry pleurisy	1	
Pansinusitis	1	
Chronic bronchitis	1	
Heat prostration	..	1
Cerebral arterial thrombosis	..	2
Bile peritonitis	..	1
Atelectasis	..	2
Diabetes	..	1
Peritonitis	..	2
Parotitis	..	1
Postoperative shock	..	5
Hematoma of wound	..	1
Fecal fistula	..	1
Prostatic obstruction	..	1
Bronchiectasis	..	1
Duodenal fistula	..	1
Liver abscess	..	1

I. Chronic Cholecystitis with Stones—149 Cases. One hundred and five (70 per cent) patients were symptom free and forty-four had persistent symptoms after operation as follows: seventeen patients had attacks of pain following operation, thirty-two indigestion and one jaundice.

II. Chronic Cholecystitis without Stones—39 Cases. Sixteen (41 per cent) patients were symptom free and twenty-three had persistent symptoms after operation as follows: nine had attacks of pain and nineteen indigestion.

III. Acute Cholecystitis with Stones—22 Cases. Eighteen (81 per cent) patients were symptom free and four had persistent symptoms after operation as follows: three had attacks of pain and indigestion; one had indigestion only.

TABLE XI
410 OPERATED CASES OF BILIARY TRACT DISEASE CAUSES OF DEATH

	1933	1939
Number of cases	200	210
Number of deaths	14	12*
Per cent deaths	7%	5.7% (3.6%)* (2.6%)†
Causes of death:		
Postoperative pneumonia	5	
Shock (death within 48 hours from so-called liver deficiency)	3	2
Pulmonary embolus	3	2
Cardiac decompensation	1	2
Postoperative	1	
Massive collapse of lung	1	1
Peritonitis	.....	2
Uncertain	.....	2
Bile peritonitis due to injury to hepatic duct	.....	1

* Excluding common duct cases.
† Excluding common duct and acute cases.

IV. Acute Cholecystitis without Stones—7 Cases. Six of these patients (86 per cent) have been symptom free. One patient complained of pain and indigestion.

V. Common Duct Stone—5 Cases. Two patients (40 per cent) have been symptom free and three have had persistent symptoms as follows: one had attacks of pain, three indigestion, one jaundice and one had a fecal fistula.

SUMMARY

1. A ten-year survey of gallbladder surgery on the Fourth Surgical Division of Bellevue Hospital is presented.

2. Four hundred and ten cases of operation for gallbladder disease are reviewed, including a discussion of chole-

cystography, biliary drainage and blood chemistry.

3. Of 222 cases followed there was a symptomatic cure in 84 per cent of cases of acute cholecystitis, 70 per cent of cases of chronic cholecystitis with stones, 41 per cent of cases of chronic cholecystitis without stones. In the cases of common duct stone, the follow-up study showed no recurrence of pain or jaundice in 60 per cent of the cases.

4. We have found a special gallbladder clinic for the preoperative study and follow-up care of gallbladder patients most valuable.

5. *X*-ray findings were confirmed by operation in 84 per cent of 147 cases. A normal cholecystogram was found to be only 50 per cent reliable diagnostically.

6. Cholangiography has been added to our diagnostic procedures as a most valuable aid in the diagnosis of stones which have been overlooked.

7. Cultures of gallbladder wall at operation were positive in thirty-three out of sixty (55 per cent) cases, the most frequent organisms being Bacillus coli, Staphylococcus aureus, and Streptococcus viridans. Cultures of the fluid contents of gallbladders removed at operation were positive in 51 per cent. The organisms found in order of frequency were Staphylococcus aureus, Bacillus coli, Streptococcus viridans.

8. We regard biliary drainage as a necessary and important link in the diagnostic chain.

9. In 209 operated cases, in which biliary drainage was done, cholesterol crystals were present in 24 per cent of the cases, calcium bilirubinate in 16 per cent, and both cholesterol and calcium bilirubinate in 17 per cent. When cholesterol crystals were present, stones were found at operation in 92 per cent. The presence of calcium bilirubinate in bile was associated with stones at operation in 79.4 per cent.

10. We have found the tilt table fluoroscope valuable in cases of unsuccessful biliary drainage.

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MALUNITED COLLES' FRACTURE*

MARCUS H. HOBART, M.D., F.A.C.S. AND GEORGE L. KRAFT, M.D.
Assistant Professor of Surgery, Northwestern University Medical School
Resident in Orthopedic Surgery, Cook County Hospital
EVANSTON, ILLINOIS

THE subject of Colles' fracture is old. The condition was recognized by few men before Colles' time and the importance of their articles went by unrecognized. About the year 1770, Pouteau, a distinguished French surgeon, specifically mentioned that fractures of the radius due to falls on the wrist, "are generally mistaken for sprains, for incomplete luxations, or for separations between the ulna and radius." This important statement might have been the seed for growth of our modern knowledge of this type of fracture but it carried no influence at the time. Nearly fifty years later A. Colles,[1] of the Royal College of Surgery in Ireland, wrote his classic on fractures of the carpal end of the radius. Even this, a clear, well described article would have gone by unnoticed had it not been for Robert W. Smith of Dublin who brought it into notice and enlarged upon it. Since that time such early writers as Malgaigne, Voillemier, Nelaton, Cooper and Fergusson contributed a great deal to the knowledge of Colles' fractures.

The first American publication on this subject was by John Rhea Barton in 1838. His writings were theoretical and doubted by many, but helped to stimulate a great deal of interest on the subject in this country. However, no articles were written until 1870, when E. M. Moore wrote a paper stressing the importance of injuries about the wrist. This was followed by a prize essay written by T. K. Cruse in 1874. In 1878, Pilcher contributed much to the practical and experimental details. He was followed by Packard[2] in 1879 who dilated upon the mechanics and treatment of this fracture. After that the contributions have been many and the strides great.

In spite of the fact that this subject has been written about so prolifically and the etiology and treatment have been covered so well, there still remains a good deal of haziness on the part of many of the medical profession not only as to the mechanics and misplacement of the fragments in these fractures, but also as to the normal alignment of the bones and the importance of their anatomical relations, as a result of improper reduction on the physician's part or due to the neglect of the patient in obtaining medical aid. Where the symptoms are marked and persistent, especially as occurs in older groups of individuals, surgical intervention should be carried out.

With the risk then of repeating what should be fundamental knowledge, the important points in the normal anatomy as well as those of the deformity will be reviewed.

In studying the normal relations of the distal ends of the radius and ulna in the lateral view, it will be noted (Fig. 1*a*) that a line drawn parallel to the long axis of the bones will form an acute angle (A B′ C) with a line drawn tangent to the distal points of the radius (A and B), and that the distal joint surface of the radius tilts toward the anterior (flexor) surface of the forearm.

In a Colles' fracture with its impaction, posterior displacement and rotation posteriorly (dorsally) of the distal fragment (Fig. 1*b*) producing the characteristic silver-fork deformity, the angle (A B′ C) becomes an obtuse angle.

In reducing this fracture, not only must the distal fragment be replaced anteriorly (toward the flexor surface), but it must be so rotated as to reform the acute angle (A B′ C). Occasionally in difficult cases a right angle (A B′ C) is all that can be ob-

* From the Department of Surgery, Northwestern University Medical School and Cook County and Evanston Hospitals. President's Address to Chicago Orthopedic Society, April 12, 1940.

tained and fixed, and may be satisfactory, but in no case is an obtuse angle to be allowed to remain. This deformity so interferes with function that pain and disability are almost bound to persist. Successive attempts at anatomical reduction should be made until the proper acute angle (A B′ C) is obtained.

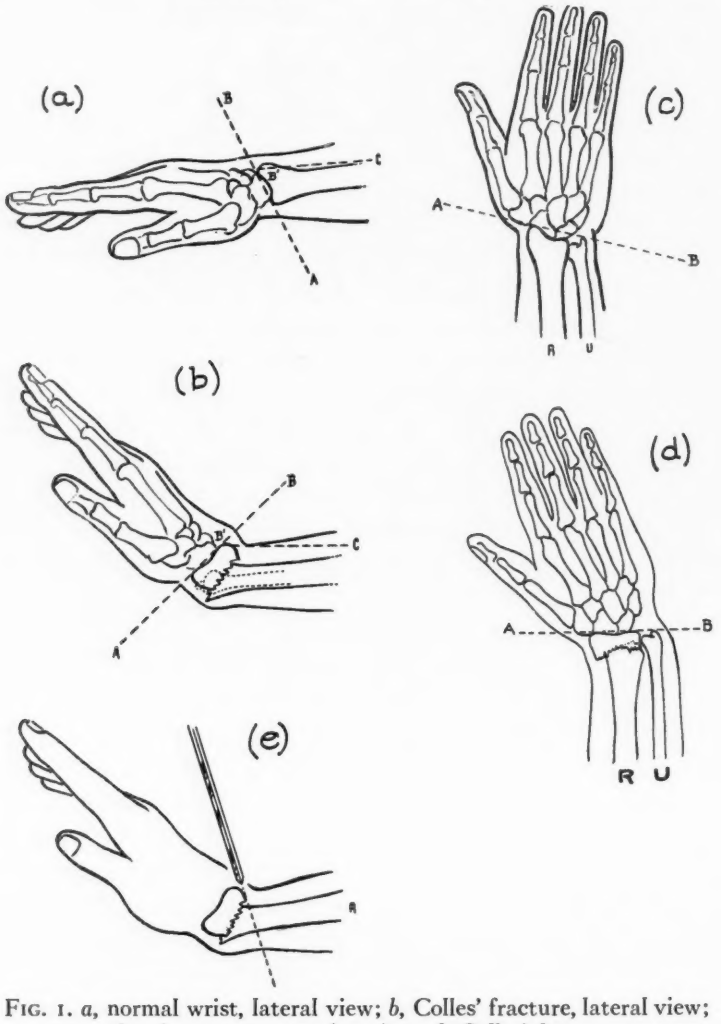

Fig. 1. *a*, normal wrist, lateral view; *b*, Colles' fracture, lateral view; *c*, normal wrist, anteroposterior view; *d*, Colles' fracture, anteroposterior view; *e*, correction of malunited Colles' fracture.

In the normal anteroposterior view (Fig. 1*c*) the styloid process of the radius (R) is distal to the styloid process of the ulna (U). In a Colles' fracture (Fig. 1*d*) two important displacements occur and should be corrected: (1) The distal fragment of the radius and with it the styloid process of the ulna, if fractured, are displaced radially, i.e., toward the radial side of the wrist, giving the deformity toward that side. (2) The distal fragment of the radius (R) is closer to the level of the ulnar styloid (U) and may be proximal to it. (Fig. 1*d*.)

In order to assure a good result, it is necessary to replace the distal fragment of the radius distally (by traction), toward the ulnar side (by pushing it over) and *to maintain it there until solid union has occurred.* Hence the wrist and hand should be held in ulnar deviation, and kept there, for if the wrist be "turned loose" too soon, the common motion of bringing the hand toward the radial side, as in eating, may result in a *recurrence* of the radial deviation and a consequent deformity with prominence and pain over the distal end of the radius and *ulna*. In order to maintain the wrist in ulnar deviation the cast should be

so cut that the distal portion over the radial side and dorsal surface remains intact. This will hold the hand and wrist in

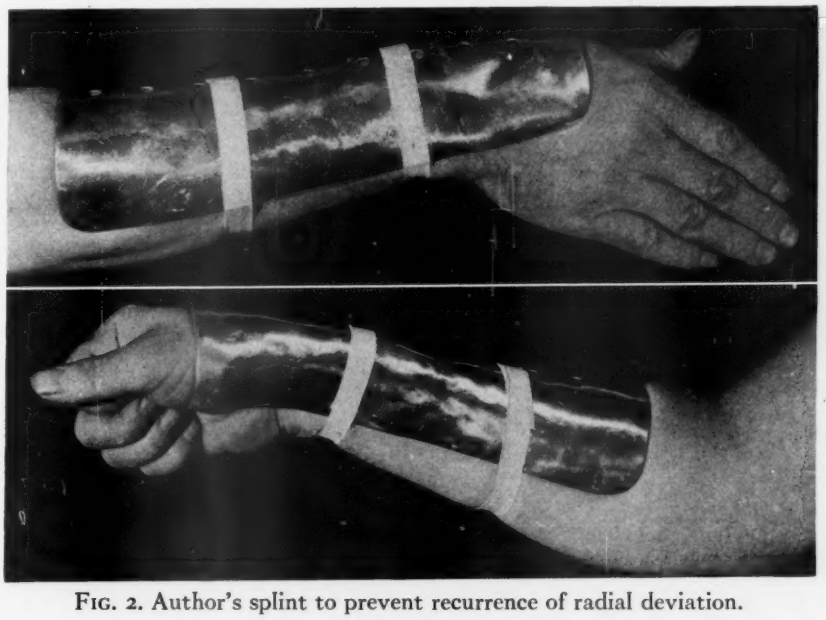

Fig. 2. Author's splint to prevent recurrence of radial deviation.

ulnar and palmar deviation, preventing recurrence of deformity. If a cast is not used, the author has devised a simple metal splint which will serve this purpose. (Fig. 2.) Most splints designed for the wrist are free on the radial side and have a straight edge on the ulnar side which tends to promote the radial deformity. This newly designed splint should prevent it.

Therefore, because many cases are either neglected or inefficiently treated, or both, poor results are obtained. Hence the malunited cases occur and demand proper treatment.

In a patient with malunion, pain deformity and loss of function persist and require relief. Most of these cases, at least after six weeks, must be operated upon. Occasional early malunions can be reduced without open operation, either manually or by means of the Thomas wrench, but most cases with solid union require operative surgery.

TECHNIC

The technic which the authors use requires a sterile preparation preferably twenty-four hours in advance. At the operation a posterior lateral longitudinal incision is made over the radius and across the fracture site. With a three-eighth inch blade osteotome preferably, subperiosteally the radius is cut across the fracture site, slanting the surface slightly toward the palmar surface. (Fig. 1*e*.) The hand and distal fragment are then shifted to the ulnar and palmar side, which leaves a triangular bone defect over the radial and dorsal surface. This defect is then filled in by bone fragments either from the more proximal part of the radius or from the distal end of the ulna, if it is necessary to make an incision there.

If the ulnar styloid has been fractured or if it is prominent or painful, a second longitudinal incision is made over the distal end of the ulna and the styloid process or even the whole end of the ulna may be removed. This fragment can then be used to fill in the defect in the radius produced by the correction.

A posterior molded plaster splint is then applied over the radial and dorsal surface of the hand, wrist and forearm and allowed to harden in place. The splint is then fastened in place by means of a circular plaster. The plaster cast should extend from just proximal to the metacarpophalangeal joints, allowing the fingers and

thumb full motion, to the elbow. In some case the splint and cast are extended to include the elbow, especially in fat arms, or when there seems to be a tendency for the replaced fragments to slip. The position after correction should be checked by two *x*-ray views, anteroposterior and lateral.

The cast in the case of corrected malunited fractures is left on at least two to three weeks without removing. It should be split down its entire length on the ulnar side if it is too tight because it disturbs the circulation, as is evidenced by swelling of the fingers, discoloration-either redness, blueness, or paleness—pain, prickling or numbness. If there is any question about it, the cast should immediately be split after applying.

After two or three weeks or more the cast is taken off and slight motion instituted in the wrist joint. The cast is then reapplied and fastened on with adhesive tape. At frequent intervals thereafter, once every other day or so, this manipulation is done, reapplying the cast afterward. Gradually the frequency of the manipulation is increased. Soon a straighter cast or splint (Fig. 2) may be substituted for the flexed one, but the *ulnar deviation of the distal fragment* and hand should be maintained for approximately three or four months. The specially cut cast or designed splint should be used. Motion in the fingers and thumb should be encouraged *from the start.*

In these cases physiotherapy by means of gentle massage, properly given, long

FIG. 3.

FIG. 4.

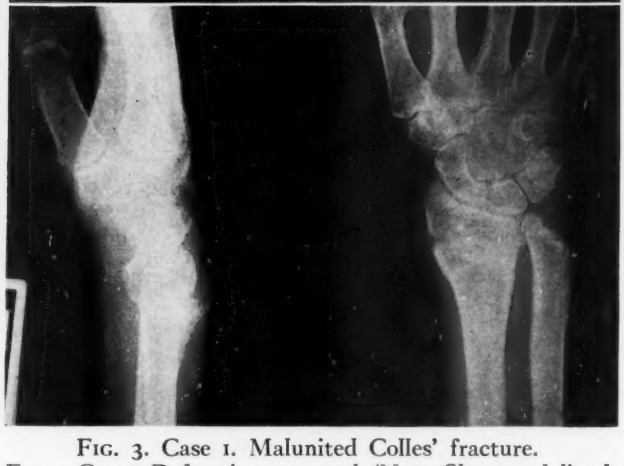

FIG. 3. Case 1. Malunited Colles' fracture.
FIG. 4. Case 1. Deformity corrected. (Note: Shortened distal end of ulna still too prominent.)

wave diathermy, active and passive exercises, heat and contrast baths may be used to promote circulation, tone up the muscles and limber the joints. Extreme care should be used at all times not to displace the fragments.

If this line of treatment is used in malunited Colles' fractures, a good result should be obtained.

For illustration three cases with four fractures so treated are here reported. All four fractures showed: (1) Constant pain located in the distal end of the radius and ulna, increasing on motion; (2) limitation of all motion at the wrist joint including flexion, extension and supination; (3) limitation of motion in the fingers; (4) marked weakness in the use of the hand; and (5) deformity.

CASE REPORTS

Case I. M. Z., a white female, age forty-nine, fell January 28, 1937, sustaining a Colles' fracture of right wrist. The patient, thinking she had nothing more than a sprain, did not seek medical attention. Because of the persistent pain in her wrist she came to our clinic at Cook County Hospital in August, 1937. An *x*-ray taken revealed typical malunion of Colles' fracture. (Fig. 3.) Open reduction was done on September 14, 1937. (Fig. 4.) She was seen on October 28, 1937. Motion of the wrist was good in all directions, pain was gone and the deformity was reduced. On April 29, 1938, there was very slight pain on the back of hand, all motion was present and there was no deformity.

Fig. 5. Case III. Bilateral fractures, anteroposterior views.

Case II. B. L., a white female, age sixty-eight, fell and injured her left wrist August, 1936. She did not get medical aid. When seen in our clinic September 28, 1937, she presented a marked deformity of the left wrist with difficulty in pronation and supination. Pain was persistently present in the wrist. An *x*-ray revealed malunion of Colles' fracture. Open reduction was done October 5, 1937. By November 20, 1937, the patient had good motion in her wrist, she was able to supinate and pronate forearm and all pain was gone.

Case III. J. R., a colored male, age forty-one, fell injuring both wrists on August 20, 1937. His wrists became swollen and tender and since that date to September 21, 1937, when he was seen in the clinic, he was unable to move the wrists. An *x*-ray taken revealed bilateral Colles' fracture with malunion. (Fig. 5.) The fractures were reduced by open operation, September 28, 1937. Results were very good as to return of function and reduction of deformity.

SUMMARY

1. Malunited Colles' fractures are too common and result from neglect or inefficient care.

2. Pain, impairment of function and deformity will usually persist if the malunion is not corrected.

3. Correction often requires open operation.

4. Posterior tilting and radial deviation are especially to be guarded against.

5. Most cases can be improved.

6. A new splint is suggested.

7. Three cases so corrected are reported with good results.

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THE thumb is the most valuable member of the hand because of its ability to oppose all other fingers either separately or together. It is worth almost as much as all other fingers put together.
From—"Surgery of the Hand"—by Couch (University of Toronto Press).

SOME OBSERVATIONS ON ENDOMETRIOSIS*

RALPH A. HURD, M.D., F.A.C.S.
Attending Surgeon, Woman's Hospital
NEW YORK, NEW YORK

IN the paragraphs which follow there will be presented some of the observations and experiences of the surgical staff of the Woman's Hospital with endometriosis, together with brief comments on the same subject in the abstract. In referring to the work of other investigators and in quoting from the literature on this subject, it is fully realized that ground already familiar to many will be retrodden. In the period of ten years which ended 1937 the pathologists, after gross and microscopic study of tissue removed at operation, returned a diagnosis of endometriosis in 361 different patients and in many individual and combined locations. In 226 of the cases, however, the particular form of endometriosis encountered was adenomyosis interna or islands of ectopic endometrial tissue in the myometrium. They were discovered only in the course of routine pathological examination in patients on whom a hysterectomy had been performed for one reason or another, were scarcely if ever recognized by the operating surgeon and were not productive of clinical symptoms. Most of these uteri were removed primarily for fibromyomas and a considerable number were the result of vaginal hysterectomy for procidentia, an operation much in favor with our staff before the present wide use of parametrial fixation. For obvious reasons these cases, although they make up about 60 per cent of the total, do not belong in a clinical review of endometriosis. The critical analysis, therefore, will be limited to the cases in which endometriosis was the sole or a prominent contributory cause of the symptoms from which the patient sought relief.

DEFINITION AND NOMENCLATURE

It is difficult or impossible to formulate in a few words a comprehensive definition of endometriosis for, as Graves has said, the subject is one which is encumbered with a profusion of ill fitting terms. These various appellations are doubtless the result of a repeated application of new names as increased knowledge of the subject has been acquired over the past thirty years beginning with Cullen's masterful treatise on adenomyomas of the uterus in 1908. For the sake of simplicity the term endometriosis should be used to include all pathologic lesions, most often found in the female genital tract, which are the result of herotopic or misplaced endometrial tissue. Other terms which may be found in the literature are adenomyosis interna and externa, adenomyomatosis, mulleriosis, adenosis, endometrioma and, in the case of the ovary, chocolate, tarry and hemorrhagic cyst. All of these lesions are endometriosis and it seems to the writer that the latter term alone is sufficient, adding in each case the area affected or the organ involved. Strictly speaking, the suffix "oma" appears to be a poorly chosen term in these cases, whether it be in connection with adenomyoma or endometrioma, for it implies true neoplastic development. Since it is now almost universally agreed that these heterotopic growths are of endometrial origin and, furthermore, that their mode of dissemination has been as Sampson described, the suffic "osis" becomes much more appropriate and, by its inherent meaning, correct.

There is, of course, a place elsewhere for the term adenomyoma which is a mixed

* From the Clinic of Woman's Hospital, New York City.

tumor of the uterus characterized by true neoplastic development of both glandular and muscular tissue growing side by side. An adenomyoma is a rare tumor, most often round, sharply defined and enucleable and the chief interest in it lies in the histologic structure. Clinically, it is almost impossible to distinguish it from the ordinary myoma, so frequently encountered in gynecological surgery.

HISTOLOGICAL

One of the earliest contributions to the subject of endometriosis, as we now know it, appeared in 1860 when Rokitansky published his observations on adenomyomas of the uterus. Other foreign authors, among them von Recklinghausen, Pick and Meyer, made valuable observations but in this country the evolution of our knowledge of the subject will always be associated with the names of Cullen, of Baltimore, and Sampson, of Albany. Any student of this condition must familiarize himself with the writings of these two observers, Cullen having begun as far back as 1896 with a paper on adenomyoma of the uterine ligaments and Sampson having produced a series of brilliant essays at short intervals through the nineteen twenties. Other authors who have presented their observations in recent years are Keene and Kimbrough, Davis, Dougal, Wharton, Pemberton, Masson, Counseller and the French gynecologists, Cotte and Mathieu.

When Sampson's first paper on endometriosis appeared, great interest was stimulated in the subject. His ingenious theory of retrograde transtubal implantation stands out as one of the major contributions to gynecological literature in modern times. For the ten or twelve years following Sampson's earlier publications no subject in gynecology received more spirited discussion, and interest in it has been maintained remarkably well to date, even though there is no longer the sharp controversy about various theories that once existed.

ETIOLOGY

A number of theories have been formulated to account for the presence of endometrial tissue or tissue closely resembling endometrium elsewhere than in the cavity of the uterus itself. These hypotheses may be found in any of the more recent textbooks on gynecology or pathology and need not be recounted in detail here. Seven or eight of them have appeared from time to time and brief reference will be made to five of them, as follows:

The first of them may be called the mucosal invasion theory and presupposes a direct invasion of the myometrium by uterine mucosa or a similar invasion of the wall of the tube by its mucosa. Endometriosis of the uterus itself (adenomyosis interna) and of the tube may be explained on this basis but lesions in the ovary, nterine ligaments and other adjacent or distant organs are, by the same token, much more difficult to explain. With this theory are closely associated the names of Cullen and von Recklinghausen whose publications appeared around the turn of the century.

A second theory may be designated the Muellerian theory wherein it is postulated that the various lesions of endometriosis are due to inclusions of Muellerian rests. A Muellerian origin for an adenomyoma of the right round ligament was suggested by Cullen in 1896 and three years later Russell reported in the John Hopkins Hospital Bulletin a case of heterotopic endometrium in the ovary, attributing its origin to an aberrant portion of the duct of Mueller. Russell's paper has been rather widely quoted and many writers, among them Blair Bell, gave his conclusions support. It is pointed out that there is a close anatomical proximity between the Muellerian duct and the anlage of the ovary and that the celomic mesothelium is the precursor of both. It is argued, therefore, that an interchange of cells from one anlage to the other might easily take place and, as Russell stated, a portion of germinal

epithelium, which forms the ovary, might produce structures which its function elsewhere calls upon it to do.

The third of these theories is known as Wolffian, wherein the lesions are ascribed to adult remains of the Wolffian tubules. With this hypothesis is associated also the name of von Recklinghausen who formulated it. He observed that growths containing endometrial tissue were frequently found in the posterior wall of the uterus and near the isthmic portion of the Fallopian tubes and that these areas were the same in which remains of the Wolffian tubules are most frequently found. Later he expanded his theory to account for involvement of the uterine ligaments and other adjacent sites and for quite a time his beliefs were accorded more or less general acceptance, only to be superceded later by the mucosal invasion theory.

The fourth or serosal theory of origin contends that the lesions of endometriosis result from the metaplasia and subsequent growth of the endothelial cells of the peritoneum. There are a number of observations which show that the peritoneum or the germinal epithelium of the ovary, under certain influences of inflammation or of unusual endocrine disturbances, can alter the character of their respective latent cells and take on an entirely different appearance. With this theory the names of Ivanoff, Meyer and Pick have been prominently associated, the latter being among the first to describe the typical chocolate cysts of the ovary which he called cystoma ovarii endometroides. Almost all of the German writers have supported this theory at one time or another and Novak has been a staunch advocate of it in this country. The latter, however, has favored a hormonal influence, rather than an inflammation, as the cause of metaplasia and hypertrophy of the celomic mesothelium.

The fifth and last theory of origin to which reference will be made is the one formulated by Sampson and it has received the widest acceptance of all. It may be called the transtubal implantation theory and this appropriate name immediately suggests the nature of the process involved. As a result of extensive combined clinical and laboratory investigation Sampson showed that detached endometrium or tubal mucosa may become implanted elsewhere, such as on the ovary, the uterine ligaments or the peritoneum covering adjacent intestine, the posterior surface of the uterus and particularly the posterior cul-de-sac. This detached epithelium escapes or is regurgitated through the tubes at the time of menstruation or, less frequently, during the course of some gynecological manipulation, either examination or operation. This transplanted tissue has a histologic structure which is identical with that of the uterine mucosa and, as it penetrates the surfaces on which it becomes lodged and grows, it is governed by its own inherent physiological laws in its reaction to menstruation, pregnancy and the menopause. Sampson gives a number of plausible reasons to support this theory that the various lesions of endometriosis are the result of true peritoneal implants derived from epithelium carried backward through the tube with menstrual blood. He points out that their structure and function are the same as the uterine mucosa and that they develop only in women during their menstrual life. He has observed blood escaping from the fimbriated ends of tubes of women operated upon during menstruation and has examined this material microscopically, finding that this blood shows epithelial cells and fragments of endometrial stroma. The early implants are most frequently found on structures which are in close anatomic relation with the fimbriated ends of the tubes and are often in various stages of development in the same individual, thus suggesting repeated implantations from the original source or from other endometrial foci in the pelvis. The tubes are usually patent, the deposits are usually multiple and scattered and similar growths have been demonstrated in the scars of abdominal incisions in cases in which it was possible to contaminate the

field with uterine or tubal tissue, such as in cesarean section. Furthermore, lesions similar to endometriosis have been reproduced in the experimental laboratory by Jacobson who transplanted fragments of uterine mucosa into the peritoneal cavity of the rabbit.

It may be appropriate here to refer briefly to the editorial comment on endometriosis by Meigs which was published in *Surgery, Gynecology & Obstetrics* a short while ago. He admits the plausability of Sampson's theory of reflux of endometrium through the tubes but prefers that of serosal metaplasia and then goes on to stress late marriage and contraception as important etiological factors in the production of endometriosis. Long postponement of conception allows an unduly long and uninterrupted menstrual life and this, in turn, results in excessive stimulation of the unutilized celomic cells by the various hormones. The stimulation of these celomic cells next causes them to take on Muellerian or uterine characteristics and thus endometriosis is produced.

PATHOLOGY

The pathology of typical misplaced endometrial tissue has been well summarized by Davis who quotes from the classical papers on the subject and emphasizes that it is governed by the same physiologic laws, in its reaction to menstruation, pregnancy and the menopause, as the mucosa lining the uterus. Wherever the situation may be, these reactions continue to go on and periodic swelling and discharge of blood occur even in endometriosis of the rectovaginal septum, the umbilicus and laparotomy scars. By the same token, decidual reaction during pregnancy is found in the stroma underlying ectopic endometrium and atrophy of the glandular structures in endometriosis occurs after the cessation of the ovarian function.

The ovary takes first place as a host or incubator for the development of endometriosis when the subject is considered clinically, although small asymptomatic lesions in the myometrium generally (adenomyosis interna) and in the cornual areas surpass the ovarian implants numerically. Ovarian endometriosis appears grossly in the form of hematomas which vary in size from pin head superficial lesions, involving only the surface layers of the organ, to the large tarry or chocolate cysts which may reach such diameters as to be palpable as masses on bimanual examination, like cysts of the ovary or fibromyomas within the layers of the broad ligament. The smaller lesions are multiple and appear as minute red or purplish deposits on the surface of the ovary, the color being dependent upon the age or the time in the menstrual cycle. The beautiful colored illustrations in Sampson's papers depict them almost as vividly as in the living subject. They are more often bilateral than unilateral and when they perforate, as they probably often do under the influence of menstruation, they become adherent to the surrounding structures. The larger endometrial hematomas appear to have their origin deeper within the substance of the ovary and do not perforate as early as the smaller deposits on the surface. When perforation occurs the ovary becomes densely adherent to the adjacent structure, whether it be the posterior layer of the broad ligament, the bladder, the opposite ovary, the appendix, the rectosigmoid, the uterus itself or the small intestines. The adherent structures now become a part of the wall of the newly formed hematoma and seal off the latter. In attempting to free the ovary at operation the site of perforation is almost invariably reopened and the typical chocolate colored contents of the cyst are liberated. While this process is not a malignant one in the true histologic sense, nevertheless there is a real invasion of healthy tissue which results in such dense adhesions that the pelvic viscera become tenaceously matted together and lines of cleavage often become difficult or impossible to establish. In our Woman's Hospital series the ovary was involved alone in fifty-four of the 135 clinical cases of endo-

metriosis and in conjunction with lesions in the uterus, tubes, ligaments and rectovaginal septum in an additional thirty-two cases, making practically two-thirds of the total. Thus the ovary becomes the most favorable site for the development of ectopic endometrial growths, a sort of incubator, as it were, and may be a permanent or, in the case of rupture, an intermediary host.

Another frequent site of endometriosis is the posterior cul-de-sac and rectovaginal septum in which location the implants result in a fusion of the anterior wall of the rectum with the posterior wall of the cervix. For many years these and closely similar lesions have been designated adenomyomatosis or simply adenomyomas and Cullen has classified them in three distinct categories: He has placed those lying free in the septum in one group, those adherent to the posterior wall of the cervix and the anterior wall of the rectum, often fusing the two, in another group and those forming a dense mass of cervix, rectum and broad ligaments into a third group. Microscopically these lesions in and about the rectovaginal septum present the typical picture of endometriosis of the ovary with small cysts and gland spaces filled with the familiar chocolate contents. Clinically, they may be palpated as discrete or diffuse nodules involving the vaginal vault and the adjacent cervix and rectal wall. On the vaginal side they may sometimes be viewed through the speculum as red or bluish indurated cysts which at times perforate and discharge their contents during menstruation, a phenomenon which rarely, if ever, occurs when the rectal wall is similarly involved. In our series of 135 cases there were four which had involvement of this region as the only grossly discernable endometriosis in the pelvis, although three others were described as having affected the contiguous cervix alone, one of the latter in the stump following low amputation. Besides, in a score or more of other cases, small deposits of endometriosis were noted deep in the posterior cul-de-sac when the main lesion was in the ovary, uterus or uterine ligaments.

Other less favorable sites for the development of endometriosis are the round, the utero-ovarian, the infundibulopelvic and the uterosacral ligaments. Of these the round ligament is most often involved and the lesions may be demonstrated in the intraperitoneal portion, the portion within the inguinal canal and the distal portion in the labium majus. The clinically designated inguinal endometriosis comes within this category and the swellings may at times attain considerable size, although they more frequently are palpated simply as small nodules. They increase in size and become more painful with the advent of menstruation just as the lesions in the ovary respond to these physiological laws. Due to its more remote situation from the fimbriated ends of the tubes, there is even more controversy over the origin of inguinal endometriosis than in the case of the ovarian type. Here the theory of development from ectopic Muellerian or Wolffian tissue becomes more tenable and some have held that endometrial cells reach the inguinal regions via the lymphatics or venous channels. In only two of our 135 cases was endometriosis of the uterine ligaments the symptom producing lesion for which operation was performed, although small deposits were found on the round and uterosacral ligaments in many of the ovarian and combined cases.

Besides the structures mentioned so far, the pelvic peritoneum, the serosa covering the sigmoid and small intestines, the umbilicus and laparotomy scars have been observed as sites of growth of ectopic endometrial tissue. Many of our combined cases showed involvement of the peritoneum, one appeared in a laparotomy scar following cesarean section and there were two cases of endometriosis of the umbilicus. The umbilical growths appear as small nodules in that region which undergo swelling, intensification of color and tenderness during menstruation and on section reveal the same histologic picture as intrapelvic

endometriosis. As in the case of inguinal endometriosis, these umbilical lesions are not easily explained by the implantation theory of Sampson and more speculation has arisen about their origin. Perhaps in this instance the serosal metaplasia theory again becomes more tenable. In practically all cases of endometriosis of laparotomy scars, the operation had involved manipulation of the uterus and the transfer of detached endometrial or tubal mucosa to the involved area. These cases seem admirably suited to the implantation theory and Danforth has proposed several ways in which this might occur. He mentions the forcing of endometrium through the tubes by pressure on the uterus during operation, the escape of endometrium during cornual excision, myomectomy, hysterectomy or cesarean section and also the transfer of endometrium by the needle and suture in the course of performing a ventrofixation.

AGE INCIDENCE AND PREVIOUS OPERATIONS

As many students of this subject have pointed out, endometriosis is an affection that is observed during the menstrual or reproductive period of life and our experience at the Woman's Hospital has proved no exception to this rule. None of our patients was under twenty and only twenty-nine of the 135 were less than thirty years of age. An even hundred of the patients were in the fourth and fifth decades of life, about equally divided between those in their thirties and those in their forties. Only five were in their fifties and but one of the entire group was over sixty at the time of observation. Many of ours in the older groups had hysterectomies for concurrent fibromyomas and the treatment was relatively simple, a fact which obviously did not hold for the women in their thirties in whom the preservation of menstruation and child bearing function was of paramount importance.

Sampson has pointed out the potential danger of initiating endometriosis by manipulation of the pelvic viscera in examination and at operation. He believes that endometrial tissue may be squeezed or spilled out of the fimbriated ends of the tubes in this manner, just as in the case of reflex during menstruation. In this connection it may be of significance that fifty-three or nearly 40 per cent of our patients had been operated upon previously. Of these, forty-one had laparatomies for one condition or another, including cesarean section, before coming to us and twelve gave a history of vaginal plastic work or curettage.

ASSOCIATED LESIONS

The student of endometriosis soon discovers that almost no other affection of the female genital tract is so often associated with other pathologic lesions and so infrequently appears alone and uncomplicated. This fact accounts largely for the difficulty the clinician experiences in recognizing the symptoms and diagnosis of this disease. As stated in the beginning, practically two-thirds of the Woman's Hospital cases were diagnosed by the pathologist after operation, rather than by the clinician, because the lesions were found in the laboratory on routine examination of fibroid uteri and other such specimens. Clinically, they were asymptomatic and excluded from this study. In the remaining third, 135 cases, which was analyzed, the ectopic endometrial lesion was grossly discernable at operation, was productive of clinical symptoms and often definitely diagnosed or strongly suspected before operation.

Even these cases showed, almost without exception, association with other pathologic lesions. The ovarian, tubal and combined endometriosis cases were practically always complicated by fibromyomas, chronic salpingitis, adherent retroversion or dense peritoneal adhesions. Only one of our four rectovaginal septum cases stood out as an uncomplicated entity, two of them being associated with multiple fibroids and adenomyosis interna and the fourth with an adherent retroversion. The cases in which the uterine ligaments were

chiefly involved were likewise complicated by chronic salpingitis retroversion and fibroids but the umbilical cases, on the other hand, were limited to that area.

SYMPTOMS AND DIAGNOSIS

The symptoms of endometriosis are by no means characteristic and no single symptom or sign may be regarded as peculiar to the lesion or pathognomonic. This is largely due to two quite obvious conditions. In the first place endometriosis may occur in any one of several different organs or in a combination of two or more of them and, as a result, the symptoms will depend upon the particular organ affected and its location. Again the symptoms are frequently produced, modified or obscured by the associated inflammatory or neoplastic disease or by the malposition of the uterus which is so often a complication.

Many writers on this subject point to dysmenorrhea, particularly the acquired type, as one of the most characteristic symptoms of the disease. Dougal held this opinion, although he admits that it was present in somewhat less than half of his cases. He states that the pain is progressively severe in intensity and may be referred to the side on which the ovary or the uterine cornu (endometriosis of the tubal angle or salpingitis isthmica nodosa) is involved. He and other English writers have held that cornual endometriosis may be an important cause of pain in one or both iliac fossae at the time of menstruation. Keene and Kimbrough found dysmenorrhea in about half of their cases and much the same figures hold for the large series from the Mayo Clinic recently reported by Counsellor. It did not appear to be so prominent a symptom in our series in which only 6 per cent of the patients came solely for the relief of dysmenorrhea. It was one of a combination of symptoms, however, in many other cases.

Abdominal pain, constant, irregular or aggravated by menstruation and excessive or irregular menstruation are the symptoms for which most patients with intrapelvic lesions consult the physician and these are likewise the prominent symptoms of endometriosis as we found them. Over half of our patients sought relief from either abdominal pain or menstrual disturbances and nearly all the rest presented a combination of these as their chief complaints. In the combined group many had dysmenorrhea but it was not often the predominating feature of the case. A few complained of backache, swelling of or bleeding from the umbilicus, bleeding from a laparotomy scar, abdominal swelling, dyspareunia and rectal tenesmus, according to the organ or area affected.

Sterility is often recorded in taking the histories of these patients, although very few of ours came primarily for relief of it. Of the 135 patients analyzed, seventy-six were nulligravidas and fifty-nine had been delivered of from one to five full-term children. Nine others gave histories of abortions or premature labors and one woman's only pregnancy resulted in an operation for ectopic gestation.

The preoperative diagnosis of endometriosis is difficult at best in the majority of cases and the entire clinical picture is more apt to suggest the diagnosis, rather than any individual symptom or physical sign. Most of the patients are in their thirties and forties, or at least over twenty-five, and complain of lower abdominal pain or backache associated with dysmenorrhea and other abnormalities of menstruation. Half or more of them are sterile and a relatively high percentage suffer with dyspareunia or rectal tenesmus or both.

Like the symptoms, the objective findings depend entirely upon the location of the lesion and a mass may be palpated in the case of a hematoma of the ovary or gross cyst formations in the cul-de-sac and rectovaginal septum. The uterus is frequently in the retroverted position and is relatively or absolutely fixed by the dense peritoneal adhesions nearly always present. Nodules on the posterior vaginal wall high up behind the cervix may be palpated or

viewed through a speculum. Involvement of special areas, such as the inguinal region, laparotomy scars or the umbilicus are, of course, more easily recognizable.

TREATMENT

The treatment of endometriosis should be surgical excision of the lesion and, since it is frequently a disease of comparatively young women in whom ovarian conservation is desirable, the question of how much to do becomes a most perplexing one. In the older patients, in whom ablation of the ovarian function does not matter so much, roentgenotherapy or radium irradiation may be employed in addition to radical surgery but most writers report only 2 or 3 per cent of their patients treated by these methods. We have had no experience with radiotherapy for endometriosis at the Woman's Hospital, although we recognize with others that ovarian function is essential to the growth of ectopic endometrial tissue and that cessation of the former results in regression and extensive atrophy of the growths. To conservative operative work some surgeons have added presacral nerve resection as a prevention against pain in the event of recurrence of the trouble but to most it seems of dubious practical value.

As to the question of conservative versus radical surgery in these cases, the writer is convinced on general principles that an effort should be made to save as much ovarian tissue as possible for women in the younger age groups. Small cysts and implants on the ovary and elsewhere on the pelvic peritoneum can be excised or destroyed with the cautery and malpositions of the uterus can be corrected after separation of the adhesions which anchor it in the cul-de-sac. By so doing the menstrual and sometimes the child-bearing function of the patient can be preserved for her and she is saved the distressing symptoms which characterize an early artificial menopause. On the other hand, more extensive lesions, particularly those which involve both ovaries, can be remedied only by more radical procedures and a supravaginal or total hysterectomy combined with the removal of both appendages gives the best results. With very few exceptions, if any, the ablation of the ovaries will bring about a regression and atrophy of endometriosis in the rectovaginal septum and in other places where possible injury to the bowel might be involved in removing it.

In the Woman's Hospital group the ratio of conservative to radical operation was exactly 5 to 4 and by radical is meant the complete removal of all ovarian tissue. Of the seventy-five patients who underwent conservative operation, forty-two left the hospital with enough of the genital tract intact to make pregnancy a possibility while thirty-three were rendered sterile by hysterectomy, the removal of both tubes or various combinations of work.

The postoperative morbidity and the immediate mortality rate are slightly greater in these cases than in a random series of gynecological laparotomies for other conditions, such as operations for fibromyomas, ovarian cysts or retroversion. This is due, of course, to the wide blunt and sharp dissection of dense peritoneal adhesions often required, the spill of the tarry material from the old cysts, the longer time consumed, the greater tendency to hemorrhage and shock, the disruption of integrity of the serosal or muscular layers of the bowel and the general trauma which accompanies extensive manipulation. Three of our patients died while in the postoperative stage, slightly over 2 per cent, and all of them showed signs of peritonitis with marked distention and ileus.

SUBSEQUENT COURSE

It is the custom in our clinic to observe patients at stated intervals for a year or more after operation and they are classified as satisfactory, partially satisfactory or failures in the light of relief of the symptoms for which they originally entered the hospital. On this basis practically all of the radical cases were satisfactory and secured complete relief from the distressing symptoms for which they consulted the surgeon.

The incidence and intensity of artificial menopause symptoms in this group were no greater than in other cases in which bilateral oophorectomy is done.

In the conservative group only four out of seventy-five were classified as complete failures and upon all of these subsequent radical operations were performed. The satisfactory cases in this entire group were close to 75 per cent, leaving only about one patient out of four who was not completely relieved of her original complaint of pain, menstrual disturbance, dyspareunia or other symptoms which she had, either alone or in combination, on admission.

Four of the forty-two patients who were left with enough organs to make pregnancy a possibility conceived and were delivered of one or more full-term children after operation, so far as is known. Others who failed to continue under observation may have become pregnant but probably not many of them. This is slightly less than 10 per cent and not quite as good as the seven out of fifty-five who became pregnant in Counseller's series. Conservative operations for endometriosis do not, therefore, seem to yield very gratifying results so far as subsequent fertility is concerned.

By way of comparison with the figures of this series, the writer would like briefly to refer to a significant study of clinical aspects of endometriosis by Cotte and Mathieu of Lyons made a year or so ago. They reported on seventy-eight cases of endometriosis, confirmed by microscopic examination, and were opposed to the radical operative measures advocated by some gynecologists. In over half of their cases, conservative operations sufficed. The administration of ovarian substance only aggravates the symptoms. One should be very sure of the diagnosis before beginning radiotherapy, as premature castration, if the diagnosis were wrong, would be very regrettable. In cases of endometriosis with multiple localizations, bilateral oophrectomy is indicated. Hysterectomy should be done only if there is an associated lesion in the uterus. Rectovaginal adenomyomas are especially serious localizations of endometriosis. They have had very good results following subtotal hysterectomy with removal of both tubes and ovaries. For the peritoneal forms as associated lesions it suffices to treat these lesions. If the treatment is not successful, more radical measures are indicated. For localized adenomyoma of the uterus, resection can still be done, but if the lesion is diffuse only hysterectomy can be considered. With unilateral tubal endometriosis, only the involved tube should be removed and, in cases of bilateral involvement, the uterus and one ovary should be conserved. With unilateral or even bilateral ovarian endometriosis, every effort must be made to conserve at least a part of an ovary.

SUMMARY AND CONCLUSIONS

The subject of endometriosis has been reviewed and reference has been made to the 361 patients who presented such lesions in the Woman's Hospital in the past decade. An analysis of only 135 of these, about 40 per cent of the total has been undertaken, as a majority of our diagnoses were returned only by the pathologist and were made on cases in which endometriosis complicated some other more important condition and had no clinical significance of its own.

In appraising the various theories of the mode of origin of endometriosis, the author believes very strongly that the transtubal implantation theory of Sampson is the most satisfactory and that it should receive the general acceptance of the profession in most cases. There are not many situations in which the metaplasia of serosal cells or the growth of Wolffian or Muellerian rests can be offered as better solutions to the problem.

Endometriosis may on rare occasions be found as an isolated lesion in the groin, the umbilicus, the scar of a laparatomy wound or elsewhere. In most cases, however, it is associated with or appears as a complication of some inflammatory or neoplastic condition of the uterus or its appendages,

or is the factor responsible for the adhesions anchoring a retroverted uterus to the structures behind it.

The symptoms of endometriosis depend almost entirely on the organ or areas involved and, in our experience, were rarely typical. Women with endometriosis seek relief for the most part from abdominal pain, backache and menstrual disturbances, just as do those who suffer with tumors, inflammatory disease or malpositions of the pelvic viscera. Dysmenorrhea, which is stressed by several writers as almost pathognomonic of the disease, was the sole or outstanding complaint in relatively few of our cases, although a majority stated that their symptoms were frequently aggravated at the time of menstruation.

About 40 per cent of our patients gave a history of previous operations on the genital tract, comprising laparotomies, vaginal plastic operations and curettements. The ratio of nulligravidous women to those who had had full term pregnancies or abortions was roughly 5 to 4 and only rarely did a woman come chiefly or solely for the relief of sterility.

We have had no experience with resection of the presacral nerves in these cases nor with radium or roentgen rays. All our treatment was operative and the radical operations gave satisfactory end results, almost without exception. It is probably wiser to be a little more radical in these than in the average run of gynecological cases because very few will become pregnant again and because symptoms are liable to persist as long as ovarian tissue remains. No hard and fast rules can be laid down for treatment because the patient's age, her history and the location and extent of the diseased condition are all factors in arriving at a decision as to how much to do.

CHIEF COMPLAINTS

Menorrhagia and metrorrhagia	41	Leukorrhea	2
Multiple symptoms	41	Bleeding from umbilicus	2
Abdominal pain	31	Prolapse	2
Dysmenorrhea	9	Bleeding from cesarean scar	1
Backache	5	Dyspareunia	1

LOCATION OF PATHOLOGY

Ovaries	54	Cervix	3
Combinations	32	Umbilicus	2
Tubal angles	27	Uterine ligaments	2
Tubes	9	Laparatomy scar	1
Rectovaginal septum	4	Groin	1

PREVIOUS OPERATIONS

Abdominopelvic	40
Vaginal, including currettage	12
Cesarean section	1
A few others had breast surgery or other irrelevant work	

CHARACTER OF OPERATION PERFORMED

Pregnancy possible	42
Pregnancy impossible but ovarian function preserved	32
Both ovaries removed	60
Roentgen ray castration	0
Radium castration	1

AGE INCIDENCE

Under 20	0	40 to 49	49
20 to 29	29	50 to 59	5
30 to 39	51	60 or over	1

PREVIOUS PREGNANCIES

None	76
Abortions only	7
Premature labors only	2
Full term pregnancies	59
Ectopic pregnancies	1

END RESULTS

	Per Cent
Satisfactory	83
Partially satisfactory	14
Failures*	3

* The failures, four in all, had conservative operations and were operated upon again.

MULTIPLE PRIMARY MALIGNANT TUMORS

REPORT OF TWO CASES

J. WILLIAM WHITE, M.D., F.I.C.S.
Director of Tumor Clinic, St. Mary's Hospital
SCRANTON, PENNSYLVANIA

THE coexistence of multiple primary malignant tumors was reported first by Billroth in 1869.[1] At present the literature on the subject represents the observations and studies of 445 authors all but eighteen of whom were content in submitting one to several case reports. The frequency with which present day surgeons and pathologists record the concurrent existence of two or more cancers in the same individual tends to make the condition appear quite commonplace. It is conceded that a multiplicity of primary malignant tumors no longer constitutes a biological curiosity. Only those whose experience with malignant disease is limited are exercised by encountering such multiple pathological entities.

Prior to 1931 cases of multiple malignancy were reported in series from eight European sources. These contributions were made by von Hansemann[43] and Feilchenfeld[7] in 1904, Redlich[33] in 1907, Gade[10] and Harbitz[14] in 1916, Reichelman[34] in 1926, Puhr[32] in 1927 and Ward[44] in 1930. During that period, also Major[25] and Orr[29] presented series of case studies in the American literature. Their material was gathered mainly from foreign sources. Owen,[30] in 1921, reported 143 cases of multiple cancers, the majority of which were either of squamous or basal cell type. In 1931, Hanlon,[16] working at the Mayo Clinic, thoroughly reviewed the literature and reported forty-eight additional cases.

In comparatively recent years case reports of multiple primary malignancies have been made by Judd and Phillips,[19] Mayo and Zellhoefer,[26] Friedman and Golden,[9] Pemberton and Waugh,[31] Greenwood,[13] Smith,[42] Eisenstaedt,[5] Kretschmer and Heckel,[22] and others.[20,23]

GENERAL INCIDENCE

Authors who have reported larger series of multiple cancers are generally agreed in that these tumors occur more frequently than can be explained by the factor of chance alone and that the actual incidence exceeds the reported incidence by several per cent.

Bilello and Montanini,[2] in reviewing 8,024 autopsies found only seven multiple cancers among 1,154 malignancies, an incidence of 0.5 per cent. Goriainowa and Schabad[12] reviewed 6,652 necropsies, 1,238 of which revealed malignancies, twenty-three multiple, an incidence of 1.8 per cent. Warren and Gates,[45] who published the results of a comprehensive survey including all cases reported between 1869 and 1932, to which they added their own series of forty cases, making a grand total of 1,259 cases, computed the incidence of multiple malignancies among all malignancies on the basis of collected statistics at 1.84 per cent. On the basis of American statistics alone, they computed the incidence at 3.9 per cent, and at 3.7 per cent in their own series. In a study made at the Mayo Clinic in 1929 and reported by Hurt and Broders[18] in 1933, seventy-one multiple cancers were observed in a series of 2,124 malignancies. From this information the conclusion was drawn that, although the statistical incidence was 3.34 per cent, the actual incidence was probably more nearly correct at 4.0 per cent because it seemed "reasonable to assume that about fifteen of the 2,053 patients with single malignant tumors seen in 1929 will, at some time later than 1931, have another primary malignant tumor."

Schreiner and Wehr,[36] in 1934, reported their experience between the years 1913 and 1933, a period during which 11,212

malignant lesions were observed. Among these there were 307 cases of multiple malignancies, an incidence of 2.7 per cent. Bugher,[3] later the same year, reviewed 4,394 autopsies in which death was attributable to cancer in 983 instances. In thirty of his cases multiple malignancies were present, an incidence of 3.1 per cent.

Burke[4] in 1936, reported the highest proportion of multiple cancers, 7.8 per cent, found in any series. He found forty-six multiple malignant lesions among 2,033 necropsies in which there was a total of 583 cancers. In explanation of the unusually high incidence among his cases, Burke calls attention to the fact that his studies were made during a very recent period, 1924 to 1935, when the recorded cancer mortality rate of the United States showed a steady rise, and that his figures were computed from postmortem series in which all the organs and tissues were subjected to careful microscopical examination.

The most recent report of multiple malignant tumor cases was made by Kirschbaum and Shively[21] in December, 1938. In a study of 10,870 consecutive necropsies they discovered twenty-five multiple cancers, an incidence of 1.77 per cent.

A cursory review of the literature reveals a wide variation in the incidence of multiple primary malignant neoplasms. In certain series the frequency is found to be as low as 0.3 per cent,[32] while at the other extreme it is observed to be 7.8 per cent.[4] Ratios usually range between 1 and 5 per cent. This statistical confusion is attributable to many factors.

SOURCES OF INCIDENCE VARIATION

In larger necropsy series there appears to be an abnormally low incidence as compared with smaller series which take into account total (morbidity and mortality) multiple cancer cases; and there is a marked variation in the percentage of multiple cancers found among all autopsies in comparison to the number found among autopsies in malignant cases alone.

Broad discrepancies result from the lack of standardized criteria. Lesions which are multicentric in origin, such as Hodgkin's disease—certainly not a cancer—cancer of the liver and multiple myeloma, when included, make for an upward trend in the incidence. The inclusion of bilateral cancers or those which occur in paired organs, as observed in the breast, kidneys and ovaries, produce a similar rise. The addition of cases in which there are multiple malignancies in the same organ or system, the skin, breast, stomach, liver and colon, likewise raises the incidence.

Tumors in the brain, some of which are histopathologically benign but clinically malignant, are occasionally reported as examples of multiple malignancies; but their individual rarity permits of only meager influence in raising the general proportion of multiple cancers.

To an appreciable degree, statistics are governed by their source. Those derived from the accumulated records of hospitals are likely to show a much higher incidence of multiple cancers than will those derived from individual experience. This is particularly true in the case of tumor clinics and cancer institutes. From these the figures may be misleading because of the greater concentration of cancerous patients. The personnel of hospitals devoted primarily to the diagnosis and treatment of neoplastic diseases is undoubtedly more keen in recognizing the coexistence of multiple cancers. Not infrequently less skilled physicians erroneously consider one primary cancer the metastasis of a coexistent separate primary malignant neoplasm without subjecting either to microscopical examination.

In so-called general hospitals it is the tendency to perform autopsies for the purpose of disclosing gross pathological lesions in organs of particular interest. In consequence, many occult cancers are missed, as may be gathered from reports on necropsies in which all tissues are subjected to minute study.[27,35] It is frequently impossible to determine grossly the exact nature of a tumor, whether it is benign or malig-

nant. Furthermore, an autopsy, no matter how carefully performed, will not disclose whether or not the subject has been relieved of a cancer months or years previously. Neither is the pathologist likely to make mention of numerous, small, discrete epitheliomas of the skin.[18]

It must be taken into account also that some malignant cells are capable of mutation and that, as a result of this quality, either the primary tumor or its metastasis may be mistaken for a second distinct primary cancer.

The inclusion of carcinosarcomatous neoplasms makes for an increase in the proportion of multiple malignancies, but it is considered proper to include multiple tumors of this nature in reports, carcinosarcomas of the thyroid gland excepted. Multiple primary sarcomas, comprising a small group, raise the incidence minimally.

The exclusion of cases from series either because they are not reported in sufficient detail or because they do not conform to arbitrary criteria, affects the incidence of multiple malignancies in a downward direction.

Finally, because of the increase in longevity and because of the concurrent rising incidence of cancer in general, there is conceivably the liklihood of a proportionate increase in the number of multiple cancers.

ACTUAL INCIDENCE

In view of the many factors involved, derivation of the actual incidence of multiple malignant neoplasms is most difficult. It is competent to presume however, that multiple cancers represent approximately 3.5 to 4 per cent of all malignancies, this being a higher proportion than usually reported but representing a figure deduced in reasonable agreement with the computations of others[18] and in compatibility with personal experience.

AGE AND SEX INCIDENCE

It might be expected that the age and sex incidence of single cancers would not vary greatly from the age and sex incidence of multiple cancers. In view of the preponderance of cancer of the skin in males, however, it is not surprising that a slight majority of male cases are reported in certain series. Furthermore, the frequency with which the male genitourinary apparatus is involved in multiple malignant neoplasia points to an apparent male predominence, but multiple cancers of the female genitalia, uterus and breast are so common as to balance this ostensible male prevalence.

In 476 cases of multiple cancers on which there was available information as to age and sex, Warren and Gates[45] found females to preponderate, 262 as against 214 males. The average age incidence for males was 58.3 years, for females it was 53.2 years. The average age incidence for the entire group was found to be 55.5 years.

The average age incidence for single cancers in males is 59 years, for females 57 years, and the average for both sexes is 58 years.

It thus appears that multiple primary cancers affect the sexes almost equally and at about the same age as do single cancers.

CAUSES OF MULTIPLE CANCERS

Despite the advancement of many ingenious and labored theories in explanation of the genesis of tumors, it must be admitted that few subjects are capable of arousing more interest or more controversy. Rather generally accepted, however, is the belief that tumors, particularly those of malignant nature, arise as the result of the interaction of two forces, an extrinsic factor adequate to incite cytogenesis and an intrinsic factor of susceptibility.

The late Willy Meyer estimated that 20 per cent of civilized human beings are predisposed to or exhibit an intrinsic susceptibility to cancer. Investigators have carried on extensive breeding experiments in order to determine the part played by heriditary factors.

In 1913, Maude Slye[38] discovered an hereditary relationship to spontaneous

malignancy in mice. Since then she has isolated strains of these animals that, regardless of environmental influence, have never developed a cancer. She has evolved other strains, however, which show a 100 per cent incidence of malignancy. Furthermore, she[39] has produced certain strains which show a tendency to develop special types of tumors, and still others that show a 100 per cent organ selectivity or susceptibility.

Maude Slye[41] contends that malignancy is transmitted as a localized recessive character and that for each type of cancer there is a unit recessive character capable of suppression by a dominant factor. She further believes that there is one unit recessive character for cancer and a similar unit recessive character which determines the site of neoplastic localization, where malignancy shall occur, both of which are suppressable by dominant characters. Accordingly, the genetic requirement for a malignant neoplasm in mice is two unit recessive characters, one for the malignancy itself and one for its localization; and the tendency to malignancy differs from the tendency to nonmalignancy in only one gene.

According to the investigations of Maude Slye,[39,40] susceptibility and nonsusceptibility to spontaneous neoplasms in mice depend absolutely upon genetic factors.

Little[24] is convinced that the matter of inheritance is more complex than indicated in the cited conclusions of Slye. Certain inheritance factors are traceable to the cytoplasm and in some cases it is believed that the tendency to cancer inheritability is transmitted through dominant rather than recessive unit characters.

While these deductions are made from investigations on laboratory animals entirely, who can deny that man and mouse are governed by the same biological laws? It may be that susceptibility and nonsusceptibility to cancer depend in both upon like factors. At the Atlantic City meeting of the American Society for Cancer Research, Doctor Madge Thurlow Macklin, of the University of Western Ontario, cited human family records showing what she believes is evidence for the inheritance of cancer tendency.

Many authors have expended profound efforts to explain the causes of multiple cancers in man. Hauser[17] is of the opinion that they arise from multiple tumor anlage in the presence of a multiplicity of stimuli. Wooley[46] expressed the thought that whether the active proliferation is initiated by one or another factor, this would seem evident, that the factor to be effective the cells must be in a special state, so that whatever acts upon one organ, may affect similarly its pair. Seecof[37] was inclined to corroborate Ewing's[6] opinion that the rather common occurrence of two or more tumors in different or the same organs of the same subject suggests nothing more than an accidental coincidence in several organs of the general biological factors in the genesis of tumors. Fried[8] and Orr[29] assumed that a state of immunity is conferred by a first malignant tumor that prevents the appearance of a second cancer. The latter impression is known to be fallacious. There is no immunity to cancer. Hanlon[16] suggested that multiple cancers develop incidentally and not in response to any law of neoplasia. Warren and Gates[45] conclude that multiple primary malignancies may be explained by a predisposition or susceptibility to carcinoma in certain persons or the action of some factor favoring the development of a malignant condition, the nature of which is unknown. This point of view coincides with that of Hartmann.[15] Bugher[3] states that there is an inherent susceptibility to cancer not possessed by all people. Broders[18] found an hereditary factor present in 28.6 per cent of case histories in a series all the histories of which did not contain pertinent data. Burke,[4] on similarly incomplete information, found evidence of the presence of an hereditary factor in 30.4 per cent of cases and pointed out that "the real importance of a higher incidence than can be explained on the basis of chance alone lies in its implication of the factors of heredity

(susceptibility) and environment (irritation, injury) in cancer etiology."

From the foregoing conclusions it is clearly evident that the concensus of opinion concerning the genesis of multiple cancers revolves about hereditary and environmental factors. It would appear that even though the unit character necessary for cancer susceptibility is present from birth, and persists throughout life, it may remain inactive in the absence of adequate environmental influences.

AUTHOR'S HYPOTHESIS

Genes present from birth need not become functionally operative for a prolonged interval. All genes do not reach functional maturity at identical periods of animal existence. Their influence, although specific, may indeed be complex. Some act singly, others multiply. Single genes are capable of producing manifold effects and, conversely, a number may be required to bring about a single result. Of greatest significance in the attempt to elucidate the etiological elements of multiple primary cancers is the knowledge that a gene is capable of producing a summation of effects upon various structures: the eye, skin, gastrointestinal and genitourinary organs.

Theoretically, the inference being drawn from cited animal experimentation, the origin of multiple malignant tumors can be explained by the interaction of a functionally mature gene bearing the unit character for cancer inheritance with a functionally mature gene having the unit character for cancer localization but endowed with the ability to effect various structures similarly. This interaction must of necessity take place in the presence of adequate environmental stimuli if multiple cancers are to be the result and the type of neoplasia will depend upon the histology of the structures acted upon by the unit character for localization. The sequence of tumor development, synchronously or metachronously, will depend upon local environmental forces, the presence or absence of persistent irritation. Tumors that develop synchronously, however, may become manifest metachronously.

A gene is functionally mature when it is competent to produce its specific simple or compound effects, regardless of the individual's age. Even though most cancers develop in and beyond the fourth decade of life, it is the writer's opinion that the inheritance factors together with environmental influences are of greater significance than chronological age and that only those who inherit both unit characters, one for the malignant tumor and one for its localization, develop cancer when provoked by stimuli adequate to produce cytogenesis. Some of the known stimuli capable of producing cytogenesis are dibenzanthracine, cholanthrine, and aniline dyes, arsenic, radium, *x*-rays, chronically irritative and infectious processes and the rays of the sun.

Susceptible tissues undergoing biological changes such as embryological development or recovery from destructive injuries may be more quickly converted into malignant newgrowths by chemical physical, thermal and bacterial irritation because the process of reproduction, plasis of cellular elements, is already initiated. This may explain the origin of malignant tumors in the newborn or developing child as well as the appearance of similar tumors arising in chronically irritated sites of tissue injury. In any case, however, the requisite intrinsic factor of cancer susceptibility and localization must interact with environmental or secondary extrinsic factors if cancer is to appear.

CRITERIA

In consequence of advancing knowledge, it is generally agreed that the postulates of Billroth are too strict criteria for the accurate diagnosis of multiple primary cancers. Hanlon[16] showed them to be impossible of fulfillment in a large percentage of malignant neoplasms and, although he adopted the postulates of Goetze, there exists an opinion[4,45] that they, too, are of

limited applicability and should, therefore, be modified.

The solution to the problem of multiple primary cancer differentiation may be resolved into an understanding of the following terse statement:

Each tumor must be a definite, distinct, atypical invasive newgrowth presenting the characteristic macroscopic and microscopic morphological features of an independent cancer, the cells of which are capable of equally characteristic metastasis.

Fig. 1. Case 1. Showing primary tumors of face and breast.

CLASSIFICATION

Various opinions have been expressed in regard to the classification of these interesting tumors. Probably the simplest division was made by Kretschmer and Heckel.[22] A change is made in the order of the latters' grouping so as to permit a closer correspondence between the sequence of groups and the reported frequency of incidence: Group 1, double malignancies of the same or symmetrical organs; Group 2, double malignancies of different organs; and Group 3, three or more malignant tumors of the same or different organs.

Fig. 2. Case 1. Appearance after treatment, May 15, 1937.

FREQUENCY OF VARIOUS COMBINATIONS

The skin is the most common site of multiple cancer localization. Approximately 30 per cent of double cancers are found in the gastrointestinal tract. Twenty-five per cent of multiple malignant tumors are distributed simultaneously in the gastrointestinal and genitourinary tracts. Ten per cent appear in the female breast and genitourinary tract concurrently and a similar number involve the female breast and the gastrointestinal tract coincidently. Less than 4 per cent involve combinations of organs such as the skin and gastrointestinal tract and the skin and genitourinary tract. Lesser percentages comprise rarer combinations of structural involvement.

Although four cases of multiple primary cancers of the skin and five cases in which both ovaries were carcinomatous have been observed by the author, these are not considered worthy of detailed report because of the frequency with which skin cases

appear in the literature and because of the absence of substantial proof of primary multiplicity in the ovarian cases.

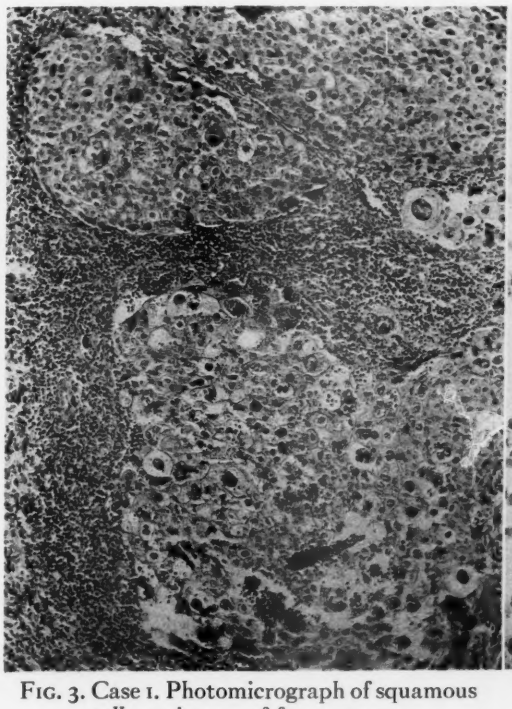

Fig. 3. Case 1. Photomicrograph of squamous cell carcinoma of face. × 100.

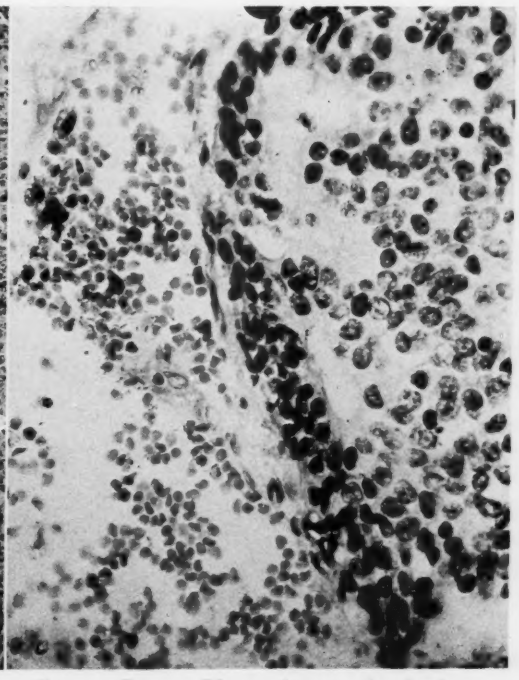

Fig. 4. Case 1. Photomicrograph of adenocystic carcinoma of breast. × 500.

The combined malignant involvement of the skin and the female breast is reported nine times in the literature. In five of these case reports the skin of the face was the locus of malignancy and in only one instance is it possible, although not specified, that the site was identical with that of the case here reported.

In eleven instances the thyroid gland is indicated as one of the sites of multiple primary malignancy. The literature reveals, however, that in none of these was the thyroid gland involved in combination with carcinoma of the lip. Because of the rarity of cancers involving simultaneously the female breast and the skin of the face, and because of the similar rarity of cancers concurrently present in the thyroid gland and the lip, the following cases are deemed worthy of detailed report.

CASE REPORTS

Case 1. K. McD., a white female, aged seventy-seven, was referred to the St. Mary's Hospital Tumor Clinic February 12, 1937, by Doctor J. J. G. The initial complaint was of "a bleeding lump on the face."

The family history was irrelevant except for the fact that one brother died at the age seventy-five of cancer of the bowel. The past history was negative.

The present condition began two years previously at which time a scale-like wart appeared in the middle of the right cheek. On November 20, 1936, an ulcer appeared in the center of the scaled area. The latter did not heal, and in December, 1936, the patient consulted her physician who made a biopsy study. Since December growth has been very rapid. Also, about two years previous to admission the patient fell and injured her right breast thus "rupturing a vein." A bloody discharge from the injured breast has recurred periodically in sufficient quantity to soil undergarments. The breast has slowly increased in size, but has not been painful.

Examination revealed a white, senile female with absence of subcutaneous fat and severe wasting. The skin over both cheeks was marked by small prominent capillaries. There was otherwise facial pallor except for areas on the both lower and upper eyelids and over the malar prominences which areas bore multiple, small, brown keratoses. Occupying the lower half of the left cheek and extending from just in

front of the lobe of the left ear to the lateral border of the corresponding malar prominence, and from 2 cm. below the zygoma, from above

Fig. 5. Case II. Showing primary tumors of lip and thyroid gland.

downward over the mandible and into the carotid and submaxillary triangles of the neck, was a firm, granular, irregular sloughing tumor. (Fig. 1.) This tumor mass bled when manipulated however gently; it discharged a foul, seropurulent exudate and was fixed to the surrounding skin and underlying structures. It projected 6.5 cm. above the skin surface. There were no palpable glands in the neck.

The left breast was small and atrophic. The right breast was distorted by a tense, irregular mass that projected anteriorly and into the right anterior axillary line. The overlying skin was fixed to the tumor and the nipple was displaced upward and outward as well as retracted. The underlying structures were minimally fixed to the growth and gentle pressure did not induce a discharge from the nipple. The supraclavicular, infraclavicular and axillary regions were free of palpable lymphnodes. (Fig. 1.)

The remaining findings, including the blood Wassermann test, were negative except for evidence of chronic, hypertrophic arthritis in both knees and a mild secondary anemia.

Both the lesion on the left side of the face and in the right breast were clinically diagnosed as malignant. The former was thought to be a squamous cell carcinoma and the latter a papillary cyst carcinoma.

On February 15, 1937, a section was removed, without anesthesia, from the facial lesion for biopsy purposes and the patient was referred to Dr. B. H. J. for local roentgenotherapy immediately after operation.

May 3, 1937, the right breast was broadly removed, under novacaine anesthesia, through a Stewart incision, together with the underlying pectoralis major and minor muscles and their respective fascias. The wound of the latter operation healed by primary intention. Neither pre- nor postoperative roentgenotherapy was applied to the breast region. The patient was discharged from the hospital, greatly benefitted, May 15, 1937. (Fig. 2.) She continued under observation at the tumor clinic.

A report on the morbid anatomy of the removed tissues follows:

"Section from the face consists of a piece of friable, grayish white tissue 2.5 by 1.5 cm. On section the tissue cuts with a grating sensation and it grossly appears to be malignant.

"Microscopically there is a marked hyperplasia and hypertrophy of the epithelial layer with projections of epithelial cells into the underlying subcutaneous tissues. There are numerous mitotic figures seen and there is marked round cell infiltration. (Fig. 3.)

"Diagnosis: Squamous cell carcinoma.

"Breast specimen includes the entire breast, skin including area surrounding breast, and underlying muscles. Section through the breast shows a large cystic mass containing connective tissue septa. The wall of the cyst bears a rough surface with papillary-like, arborescent projections. Gross examination is quite typical of a malignant cyst, the contents being hemorrhagic.

"Microscopic section shows large nests of epithelial cells occasionally arranged in a somewhat adenomatous pattern. Surrounding these nests of malignant cells are large blood sinuses. There is very little reticulum. (Fig. 4.)

"Diagnosis: Duct type, adenocystic, carcinoma undergoing hemorrhagic degeneration."

Unto date there is no evidence of recurrence of the breast tumor. The facial lesion has com pletely healed, but there is a metastatic node in the right carotid triangle of the neck just below and posterior to the angle of the mandible. This latter lesion is being treated by Dr. B. H. J. with roentgenotherapy.

Case II. C. C., a white male, aged sixty-four, was referred to the St. Mary's Hospital Tumor Clinic by Dr. J. J. B. on October 9,

1938. The complaints were of an enlargement of the neck and a sore on the lower lip.

The family history was unknown, relatives being in Poland. The past history was irrelevant. Alcohol was used sparingly and cigarettes likewise sparingly. The patient had lost indefinite small amount of weight in the past six months.

Fig. 6. Case 11. Photomicrograph of squamous cell carcinoma of lip. × 100.

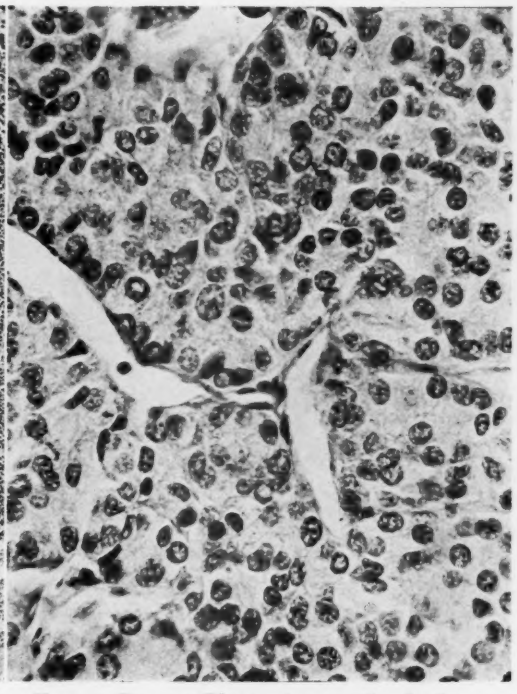

Fig. 7. Case 11. Photomicrograph of adenocarcinoma of thyroid gland. × 500.

Physical examination revealed a white, partially stooped male approximately sixty years old. The color was good, the skin dry and soft, panniculus adiposa minimal. Station was well maintained. The organs of the head were essentially normal except for the lower lip (Fig. 5) in which there was a deep ulcer measuring 3 cm. in length and 1.5 cm. in width and which occupies principally the central portion of the vermillion surface. The floor of the ulcer was granular and necrotic. Its borders were irregular, edematous and indurated. There was no leukoplakia.

The upper and lower teeth were worn to about two-thirds their normal length. Several upper and lower molars were absent. The gums were edematous and discharged a purulent exudate.

The anterior two-thirds of the neck was occupied by a diffuse, generally smooth, somewhat fixed, irregular, firm but not hard swelling characteristic of thyroid gland enlargement. (Fig. 5.) The overlying skin was moveable within limits in all directions. A nodule, corresponding to the right lobe of the thyroid gland faded diffusely into the larger mass. The circumference of the neck at its largest site, junction of lower and middle thirds, measured 43 cm. The supraclavicular space on the left was obliterated and the lower limits of the enlargement extended behind the clavicles and deeply into the suprasternal fossa. Upon swallowing there was an anterior propulsion rather than a rise of the tumor.

There was a smooth, soft freely moveable lymphnode which measured 2 by 1.5 cm. in the middle of the right posterior cervical triangle.

Kyphosis of the dorsolumbar spine and chronic hypertrophic arthritis of the joints of both hands were observed.

Roentgenray studies of the chest revealed a deviation of the trachea to the left and a grade 3 silicosis.

The pulse was regular, full, of normal tension and varied in rate between 80 and 86 per minute. The blood pressure was 140/80. The basal metabolic rate was plus 15. There were no tremors of the extended digits. The blood Wassermann test and the urine reports were negative.

On October 17, 1938, under novocaine anesthesia, the lymph node in the right posterior

triangle was completely enucleated and a section was removed from the lip for biopsy purposes.

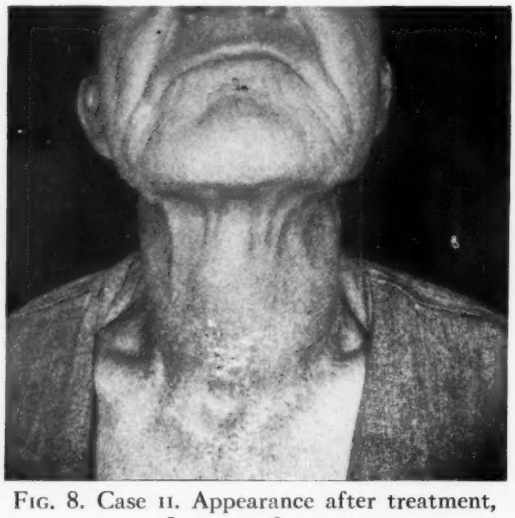

FIG. 8. Case 11. Appearance after treatment, January 26, 1939.

An attempt was made to remove the thyroid tumor surgically, under gas-oxygen-ether anesthesia on October 25, 1938, but difficulties were encountered and the procedure was abandoned.

Sections from the lip (Fig. 6), "show a marked hyperplasia and hypertrophy of the epithelial layer with finger-like processes extending into the underlying tissues. The basement membrane at the tip of these processes is disrupted. There is marked round cell infiltration.

"Diagnosis: Squamous cell epithelioma."

Sections from the lymphnode (Fig. 7) "show a soft, yellowish, friable substance grossly suggestive of tuberculous adenitis. Microscopically there appear typical cells of thyroid gland acini in irregular arrangement. Occasionally an acinus is found containing colloid. The lymphnode is completely invaded with epithelial cells.

"Diagnosis: Metastic adenocarcinoma from thyroid gland."

Roentgenotherapy was applied to the lip and thyroid tumors by Dr. B. H. J. during and subsequent to the patient's discharge from the hospital on November 16, 1938. When last examined at the Tumor Clinic, January 26, 1939, there was complete healing of the lip lesion and the thyroid tumor had resolved to a degree in which it was not palpable. (Fig. 8.) There was no evidence of regional or distant metastasis; there was a gain in weight and strength, and the only complaint was of a slight residual hoarseness. This patient continues under observation at the Tumor Clinic.

SUMMARY AND CONCLUSIONS

1. The incidence of multiple primary cancers is between 3.5 and 4.0 per cent of all malignant lesions.

2. The genesis of multiple cancers is explained on the basis of the interaction of a functionally mature gene bearing the unit character for cancer inheritance with a functionally mature gene bearing the unit character for localization but endowed with the faculty to affect various structures similarly. This interaction must of necessity take place in the presence of environmental stimuli adequate for the production of cytogenesis. The type of neoplasia is dependent upon the structures affected by the unit character for localization.

3. The sequence of tumor development, synchronously or metachronously, depends upon local environmental forces, persistent irritation.

4. The criteria of multiple cancers is simplified as follows: Each tumor must be a definite, distinct, atypical, invasive new growth presenting the characteristic macroscopic and microscopic morphological features of an independent cancer, the cells of which are capable of equally characteristic metastasis.

5. The classification of multiple cancers is revised as follows: Group 1, double malignancies of the same or symmetrical organs, Group 2, double malignancies of different organs; Group 3, three or more malignant tumors of the same or different organs.

6. Although a number of bizarre combinations of multiple primary tumors have been reported in the literature, certain rare combinations such as found in the present case reports are worthy of publication.

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OVARIAN HEMORRHAGE*

AN ANALYSIS OF TWENTY-EIGHT CASES FROM THE RECORDS OF THE JEFFERSON MEDICAL COLLEGE HOSPITAL, 1930 TO 1939 INCLUSIVE

MARIO A. CASTALLO, M.D., F.A.C.S.
Associate in Obstetrics, Jefferson Medical College

AND

LOUIS G. FEO, M.D.
Assistant Demonstrator of Obstetrics, Jefferson Medical College

PHILADELPHIA, PENNSYLVANIA

THE purpose of this paper is to report twenty-eight cases of ovarian hemorrhage and to suggest a new clinical term.

Ovarian hemorrhages, previous to 1900, were not clearly differentiated from those resulting from extra-uterine pregnancy,[1] although in 1845 Scanzoni reported a case of fatal hemorrhage from the ovary at menstruation in a girl eighteen years old. This clinical entity was referred to by earlier writers as apoplexy of the ovary.[2] Subsequent reports refer to hemorrhage from the ovary by lengthy and descriptive titles, as follows; intraperitoneal or abdominal hemorrhage of ovarian origin,[3,4] ovarian rupture causing intraperitoneal hemorrhage,[6] acute hemorrhage from corpus luteum and Graafian follicle,[7] hemoperitoneum from ruptured corpus luteum,[20] perforative ovarian hemorrhage and the nonperforative type,[3] ovarian hemorrhage,[5] etc.

The authors are of the opinion that these headings, which have reference to a single clinical entity, may be gathered under one word, oophorrhagia.

The term, oophorrhagia, is proposed because it seems advisable to use a specific name, not only for the purpose of indexing these cases, but also to emphasize such an important and easily misinterpreted clinical condition. Parenthetically, the cases found by us and others in reviewing the clinical material available are relatively few, not because they are uncommon but because of the many diagnoses under which these cases are classified. The word oophorrhagia is derived from the Greek—ᾠόν—egg,—φέρειν—to bear, and—ῥηγνύναι—to burst out, a bursting out from the ovary. The ending, "rrhagia," by common usage denotes hemorrhage from the prefixed organ, of which there are many examples.

Oophorrhagia is that condition in which there is bleeding from an ovulatory site. The authors wish to confine the term to hemorrhage from an ovulatory site severe enough to cause clinical symptoms or signs. The amount of the hemorrhage varies from slight to profuse and from an intra-ovarian to the free peritoneal type. Various combinations of these types occur, but oophorrhagia, in its most characteristic form, is exemplified by the severe cases of bleeding into the peritoneal cavity. Clinically, the cases may be divided into two large groups: the severe types of abdominal hemorrhage and the discreet bleedings. The latter does not produce well defined diagnostic symptoms and signs. So true is this, that a very large percentage are never recognized. When the bleeding escapes freely into the abdominal cavity, the clinical picture is distinct.

The incidence of ovarian hemorrhage as stated by Simon[4] varies from 0.33 per cent to 1.04 per cent of all gynecologic and surgical laporatomies. The number of such cases reported has grown rapidly. Reviewing the literature for instances of acute hemorrhage from the corpus luteum and Graafian follicle, Novak[3] found forty cases in 1917. Johnson[7] in another exhaustive search brought the total number to seventy-seven in 1930, while Israel,[6] in his report

* Read before the Jefferson Society for Clinical Investigation, March 21, 1940.

of 1937, states that more than 300 cases had been recorded. There have been twenty-eight cases of oophorrhagia, as defined above by the writers, in a ten-year period, 1930 to 1939, taken from the records of the Jefferson Medical College Hospital. The authors do not believe, however, that an incidence of twenty-eight cases over a ten-year period represents the true occurrence of this condition. The use of a specific term under which to group this entity, and more meticulous attempts at diagnosis would undoubtedly reveal a greater number.

The etiology of clinically evident ovarian hemorrhage is a moot question. The number of different opinions expressed is an admission of lack of proven facts. The ordinary rupture of a Graafian follicle causes very little bleeding due to the relative avascularity of the stigma and the formation of a rounded clot in the follicular cavity.[5] If conditions present in the abdomen cause hyperemia of the thecal vessels adjacent to the stigma or the clot fails to form, moderate to severe hemorrhage ensues. Ovarian bleeding may be due to bursting of varicose dilatations in the ovarian stroma when the follicle ruptures, as described by Schroder;[1] while Johnson[7] believes that a premature separation of the ovum with hemorrhage, and premature rupture of the follicle, accompanied by the bleeding incident to the lacerations in the ovary, are the mechanisms producing the condition. On the other hand, rupture of the corpus luteum is an unnatural phenomenon. Hemorrhage, resulting from injury, or a solution of continuity of the thin-walled, vascular, bud-like projections in the lutein layer, during the formation of the corpus luteum, may be caused by sudden hyperemia of pelvic organs, an increase in intravascular pressure or increased intra-abdominal pressure.[7] Other etiologic factors, quoted in the literature are, inflammatory ovarian conjestion or sudden trauma,[8] excessive menstrual hyperemia,[9] chronic oophoritis,[6] ordinary activities such as walking, dancing, washing clothes,[3,20] during coitus,[5,7] bimanual pelvic examinations,[9,10,13] focal endarteritis[11] and a host of general diseases.[9]

A careful review of the twenty-eight records reported in this series fails to reveal any definite etiologic factor. Seven patients gave a history of constipation with purgation and enemas being employed when the ovarian hemorrhage occurred; only one instance of definite exertion is recorded. Although this finding fits in with quoted theories of increase in pelvic conjestion or intra-abdominal pressure during ovulation, it is doubtful ground on which to base the cause of this clinical entity. Of more moment are the following facts: Eighteen or 64.2 per cent of the twenty-eight patients were nulliparous, the greater number were single women with fifteen or 53.5 per cent falling within the age group of fifteen to twenty-five years. (Tables I and II.) The possibility of an endocrine imbalance seems to us more acceptable. Ovulation, with the nicely adjusted phases of folliculization, egg expulsion and formation of the corpus luteum, is possible only when a balance of the involved hormones exists. An imbalance of this intricate and delicate mechanism may cause abnormal or pathologic sequelae, one of which may be oophorrhagia.

Table I

Age (Years)	No. of Cases
15–20	6
21–25	9
26–30	8
31–35	3
over	2

Table II

Parity	Po	P1	P2	P+	?
No. of cases	18	0	3	0	7

The characteristic picture of a severe case of oophorrhagia is portrayed by the following history:

Case 1. F. R. a white female aged twenty-nine years, single, entered the hospital with severe, sharp, continuous, left lower quadrant pain and prostration. She had been entirely well, except for a mild coryza, until twelve

hours previously, when she was seized with severe pain, low on the left side of the abdomen. Enema and citrate of magnesia had given no relief and with the continuance of the attack, the patient complained of drowsiness and thirst. There were no symptoms referable to the bowel or urinary tract and the last menstrual period had been normal.

On physical examination the abdomen was found slightly distended, with increased tension in the lower left quadrant and with general abdominal tenderness, particularly so in the left quadrant. Rebound tenderness was present but no definite evidence of fluid and no abnormal masses were palpable. The genitalia were negative and on rectal examination, no fullness or bogginess of the peritoneum was demonstrable. Temperature was 99.6°F., pulse 100 and respiration 22. The red blood cell count was 3,250,000, hemoglobin 54 per cent and leucocytic count was 7,300. The urine was essentially negative. A preoperative diagnosis of hemorrhage from a corpus luteum was made.

Operation revealed free blood in the peritoneal cavity and old clots with a ruptured, left ovarian corpus luteum. The ovary was resected.

The above history is in contrast to the following, a mild case of ovarian hemorrhage:

Case II. D. T., a white female, aged twenty-five years and single, entered the hospital because of persistent, dull pain in the lower right quadrant and nausea, which came on suddenly about forty-eight hours previously. The patient stated that the pain was cramp-like and that by evening of the first day she became nauseated without vomiting. During a restless night, the nausea and pain continued but the latter was dull in character. The last two menstrual periods were uneventful and there was no constipation.

Physical examination was negative except for tenderness on firm pressure in the right lower quadrant with rebound tenderness. No rigidity was noted but more muscular spasm was present in the left lower quadrant. Pelvic examination was negative. Vaginal and cervical smears did not show intracellular diplococci. The urine was clear. The temperature was 99°F., pulse 100 and respirations 20. The red blood cell count was 4,350,000; hemoglobin 90 per cent, and white blood cell count 6,300. The sedimentation rate was within normal limits. With a preoperative diagnosis of appendicitis the patient was operated upon.

At operation, a recently ruptured corpus luteum of the right ovary was found. The ovary was normal in size, with a circular opening on its surface of 3 or 4 mm. in diameter; this opening appeared to be plugged with a clear, jelly-like material. The appendix was removed. The final diagnosis was ruptured corpus luteum with slight hemorrhage.

One death occurred in this series. It was an unusual combination of acute appendicitis and ruptured corpus hemorrhagicum of the right ovary, with marked intra-abdominal bleeding, in a married white woman, forty-five years of age, who was admitted to the hospital in very poor condition several days after onset of symptoms.

In this series of twenty-eight patients all of whom were white, (McLaughlin[21] found 96.5 per cent white patients in his series), eight were of sudden onset, thirteen complained of sharp abdominal pain, usually more intense and localized to the lower right quadrant, a few had peri- or subumbilical pain. Tenderness of the lower right quadrant was found in twenty-one, noted usually as below McBurney's point, and three in the lower left quadrant. Six patients had rebound tenderness in the quadrant involved, usually the right, while ten had slight unilateral rigidity of the rectus muscles. Nausea occurred in eleven patients, vomiting in four and, significantly, syncope in only three, while slight vaginal bleeding or "spotting" occurred twice. Fourteen of the patients had a pulse rate recorded between 90 and 109 per minute, and twenty-four temperature recordings were between 98 and 99.8 degrees F. The respiratory rate varied between 20 and 24 per minute in twenty-three. The blood pressure remained above 110 systolic in twenty-two patients and a leucocyte count ranging between 5,300 and 9,900 was found in sixteen patients. (Table III.)

From the above varied symptoms and signs, one can readily understand the large

percentage of inaccurate preoperative diagnoses reported in the literature. In this series, the preoperative diagnoses of appendicitis was made fifteen times, or 53.5 per cent, while ovarian hemorrhage was diagnosed correctly in only five instances, or 17.8 per cent. The following

Table III

	Signs	No. of Cases
T	98°–99.8°	24
e	100°–100.8°	3
m	101°–over	1
p.		
P	70–89 per min.	7
u	90–109	14
l	110–over	7
s		
e		
R	19–less per min.	1
e	20–24	23
s	25–over	4
p.		
W.	5,300–9,900	16
B.	10,000–15,000	5
C.	16,000–over	3

preoperative diagnoses were also made: "appendicitis or ovarian hemorrhage" twice, "ectopic or ovarian hemorrhage," "appendicitis or ectopic," "ectopic," "salpingitis," one of each and in two cases the preoperative diagnosis was not recorded. (Table IV.)

A correct preoperative diagnosis will depend on the following facts:

Table IV

Preoperative Diagnoses	No. of Cases
Acute appendicitis	4
Subacute appendicitis	6
Chronic appendicitis	5
Rupt. ovarian cyst	5
Ectopic	1
Salpingitis	1
Acute append.; ectopic	1
Rupt. ovarian cyst; ectopic	1
Rupt. ovarian cyst; chr. append	2
Unrecorded	2

1. To include oophorrhagia as a possibility, in the differential diagnosis of abdominal conditions in women.

2. To evaluate the symptomatology in the light of its relationship either to the time of ovulation or to the premenstruum.[6] In our series, the condition occurred between the first and second weeks after a normal menstrual period in ten cases, after the third week in four cases, and only two cases occurred during the menses. (Table V.)

Table V

Relation to Menstruation	No. of Cases
First week postmenses	4
Second week postmenses	6
Third week postmenses	4
With menses	2
Unrecorded	12

3. To note that the normal or slight elevation of the temperature and leucocyte count are out of proportion to the severity of the pain.[12] With recession and gradual disappearance of the symptoms, as contrasted to the increasing severity of symptoms and signs in appendicitis.[13]

4. To note signs of internal bleeding with an absence of the signs of pregnancy.

5. To note that the cases lack a history of injury.[14]

The simultaneous occurrence of other pathologic states with oophorrhagia must be borne in mind. This possibility is well illustrated in the literature and in the series herein reported. Hematosalpinx,[9] ectopic pregnancy[3] and acute appendicitis[12] were found occurring simultaneously with ovarian hemorrhage at operation. Twenty-six of the twenty-eight patients were operated upon, showing at operation various degrees of ovarian bleeding. Three of these patients, in addition, revealed other pathology. One was complicated by chronic salpingitis, proven on microscopic examination and two cases were complicated by acute appendicitis, both grossly and on microscopic examination. One of the latter cases showed both salpinges markedly inflamed, though no pus could be expressed from the ostia. Of the twenty-six patients operated upon, though with sundry preoperative diagnoses, twenty-three were proven due to but one condition alone, that of primary ovarian hemorrhage.

The amount of blood found at operation varied from 2 to 3 ounces to an overflowing of the incision on opening the peritoneal cavity. Fourteen patients had free blood in the peritoneal cavity. Eight showed intra-ovarian hemorrhages and four were reported as ruptured corpus luteal or follicular cysts. The right ovary was involved in seventeen patients while the left was the seat of the pathology eight times. (Table VI.) The corpus luteum was the cause of the hemorrhage in nineteen instances while the Graffian follicle was involved six times, with one in doubt. The operative procedure most commonly employed was oophorectomy. This was done in twelve cases. Unilateral salpingo-oophorectomy was resorted to in seven, and resection of the ovary in five instances. Needling of a small cyst in the opposite ovary was done in one patient. This is important when one recalls Ferguson's case.[19] While performing a supravaginal hysterectomy, Ferguson noticed a large corpus luteum on the right ovary which he left intact. Twelve hours later, the same patient had symptoms and signs of abdominal hemorrhage; a second laparotomy revealed that the uncared for corpus luteum was found to have ruptured.

TABLE VI

Ovary Involved and Type	No. of Cases
Right	17
Left	8
Bilateral	1
Corpus luteum (corp. hemorr.)	19
Graafian follicle	6
?	1

The prognosis in oophorrhagia is good. Hedde, quoted by Sackett,[4] found only fifteen instances up to 1913 in which ovarian hemorrhage was dangerous to life. Johnson[7] in his collective review of seventy-seven cases, in 1930, included six deaths, or 7.8 per cent. In our series there occurred one death due to hemorrhage, although the case was complicated by acute appendicitis, a mortality of 3.5 per cent.

As to the proper treatment to be followed in cases of oophorrhagia, the literature is more or less in agreement. In case of doubt, operate. Pratt,[10] Brakely and Farr[12] and Harris[14] state that nonoperative treatment may be applicable in many instances, provided appendicitis and ectopic gestation are ruled out. In many cases operation could have been avoided, according to Meigs and Hoyt[12] because exploration showed that the bleeding had ceased or that it was simply physiologic. Stuckert[5] Ravdin and Miller,[16] on the other hand, declare that it is best to operate in all cases, even when the symptoms are mild, as a definite diagnosis cannot be made without laparotomy nor the possibility of continued bleeding be estimated. We are of the opinion that when in doubt the only procedure is laparotomy unless the diagnosis can be ruled out by doing a posterior colpotomy incision or the services of a trained peritoneoscopist are available. Conservatism must be practiced at operation, for many of the patients are in the prime of their reproductive period. This procedure is also advocated by McSweeney and Wood.[20]

CONCLUSION

Oophorrhagia manifests itself by definite symptoms and signs in its severe forms, not unlike any other acute abdominal condition, with or without a definite expression of hemorrhage. Ovarian hemorrhage may assume a mild form, expressing itself in symptoms and signs of slight peritoneal irritation. In the former cases, the differential diagnosis from ectopic pregnancy and acute appendicitis is necessary in the latter form, the milder inflammatory diseases of the appendix or adnexa. It is obvious that the former two conditions, together with the severe ovarian type of bleeding, demand operative intervention but the second group of patients, including the milder forms of bleeding, demand careful study.

SUMMARY

1. A term is suggested to emphasize the clinical entity—ovarian hemorrhage. The term as defined is limited to hemorrhage

from an ovulatory site as exemplified by the cases herein studied.

2. All of the patients were white, in a hospital having approximately 50 per cent colored admissions. Sixty-four and two-tenth per cent of the patients were nulliparous, the greater number single women, 53.5 per cent falling within the age group of fifteen to twenty-five years.

3. Peritoneoscopy or posterior colpotomy is recommended in doubtful cases of lower abdominal pathology in women.

4. Conservatism is advocated in the cases brought to operation.

We wish to thank the members of the staff of Jefferson Hospital for the use of these case records. A tabulation of the services on which the cases reported occurred follows:

	No. of Cases
Shallow, Dr. Thomas A.	9
Klopp, Dr. Edward	5
Bland, Dr. P. Brooke	2
Castallo, Dr. Mario A.	2
Montgomery, Dr. John	2
Dugger, Dr. John	2
Bland, Dr. George	1
Muller, Dr. George	1
Stuckert, Dr. Harry	1
Spangler, Dr. Clyde	1
Surver, Dr. James	1
Wakling, Dr. Adolph	1
Total	28

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A STUDY OF THE IMMEDIATE POSTOPERATIVE COMPLICATIONS AND MORTALITY IN CERTAIN GENERAL SURGICAL OPERATIONS*

ANALYSIS OF 662 CASES AT THE PHILADELPHIA GENERAL HOSPITAL, 1936 TO 1939

L. KRAEER FERGUSON, M.D.
Assistant Professor of Surgery, University of Pennsylvania

AND

LEROY W. LA TOWSKY, M.D.
Resident Physician, Philadelphia General Hospital

PHILADELPHIA, PENNSYLVANIA

THIS study was undertaken to obtain facts concerning the immediate postoperative complications and mortality in the cases commonly coming to the general surgical department of a large charity hospital. Certain groups of operations were selected so as to give numbers sufficient for statistical analysis. The groups of operations considered in this study were appendix surgery, peptic ulcer surgery, hemorrhoid surgery, biliary tract surgery and hernia surgery. A total of 662 cases was studied. All of these cases were consecutive cases admitted to the Surgical Services of Dr. E. L. Eliason and Dr. L. K. Ferguson at the Philadelphia General Hospital between January 1, 1936 and July 1, 1939. This interval represents a time period of two and one-half years.

Complications were arbitrarily divided into five groups. The complications which occurred among the cases studied were as follows: 1. *Wound Complications:* Grades A, B, and C. 2. *Abdominal Complications:* Nausea and vomiting, postoperative distention, gastric dilatation, subdiaphragmatic abscess, pelvic abscess, peritonitis, fecal impaction. 3. *Pulmonary Complications:* Acute bronchitis, postoperative atelectasis, postoperative pneumonia, pulmonary infarct, pulmonary embolism. 4. *Upper Respiratory Complications:* Vincent's angina, acute follicular tonsillitis, upper respiratory infection. 5. All Other Complications: Liver shock, headache, decubitus ulcer, phlebitis, bleeding (wound), conjunctivitis, parotitis, incontinence of urine and feces, cystitis, toxic delirium, icteric toxemia, polyneuritis.

RESULTS

The incidence and types of immediate postoperative complications and mortality in relation to the types of operations performed are summarized in Table I. There were no deaths in those cases subjected to hemorrhoidectomy or herniorrhaphy. Of the former 3.28 per cent of the cases developed postoperative complications and of the latter 13.4 per cent developed postoperative complications. Of the patients subjected to appendectomy 1.3 per cent died and 20.8 per cent developed postoperative complications. Of those subjected to peptic ulcer surgery 19.6 per cent died and 39.2 per cent developed postoperative complications. Of those subjected to biliary tract surgery 11.1 per cent died and 39.5 per cent developed postoperative complications. The specific types of complications and causes of mortality will be taken up in the discussion of the operations themselves.

The incidence and types of immediate postoperative complications and mortality in relation to pathology of appendicitis existing at the time of operation are summarized in Table II. The total number of cases of appendicitis studied was 240. The mortality rate for this group of cases was 1.25 per cent. Of the three patients who died all presented themselves at the hospi-

* From the General Surgical Services of Doctors E. L. Eliason and L. Kraeer Ferguson, The Philadelphia General Hospital, Philadelphia, Pennsylvania, 1940.

TABLE I

INCIDENCE AND TYPES OF IMMEDIATE POSTOPERATIVE COMPLICATIONS AND MORTALITY IN RELATION TO TYPES OF OPERATIONS. ANALYSIS OF 662 CASES PHILADELPHIA GENERAL HOSPITAL

	Total		Appendectomy		Peptic Ulcer Surgery		Hemorrhoidectomy		Biliary Tract Surgery		Herniorrhaphy	
	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Pre Cent	No.	Per Cent
Total cases	662	.....	240	.....	46	.....	183	....	81	.....	112	
Mortality	21	3.18	3	1.3	9	19.6	0	0	9	11.1	0	0
Total complications	121	18.25	50	20.8	18	39.2	6	3.28	32	39.5	15	13.4
Wound complications	21	3.18	11	4.6	1	2.2	1	0.55	2	2.47	6	5.36
Abdominal complications	39	5.9	23	9.6	4	8.7	2	1 09	9	11.1	1	0.89
Pulmonary complications	36	5.44	7	2.9	11	23.9	1	0.55	10	12.34	7	6.25
Upper respiratory complications	6	0.9	2	0.83	1	2.2	0	0	2	4.47	1	0.89
All other complications	19	2.87	7	2.9	1	2.2	2	1.09	9	11.1	0	0
Causes of Death												
Liver shock	5	0.75	...	.....	..	....	...	....	5	6.2		
Peritonitis	5	0.75	2	0.8	2	4.3	...	....	1	1.2		
Subdiaphragmatic abscess	3	0.45	...	.....	2	4.3	...	....	1	1.2		
Postoperative pneumonia	5	0.75	...	.....	4	8.7	...	....	1	1.2		
Pulmonary embolus	1	0.15	...	.....	1	2.2						
Postoperative parotitis	1	0.15	1	0.4								
Icteric toxemia	1	0.15	...	.....	..	....	...	....	1	1.2		

TABLE II

INCIDENCE AND TYPES OF IMMEDIATE POSTOPERATIVE COMPLICATIONS AND MORTALITY IN RELATION TO TYPES OF APPENDICITIS PRESENT AT OPERATION. ANALYSIS OF 240 CASES. 1936 TO 1939. PHILADELPHIA GENERAL HOSPITAL

	Acute Appendicitis		Acute Appendicitis with Perforation, Gangrene or Abscess		Chronic Recurrent Appendicitis		Total Cases Appendicitis	
	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
Total cases	120	....	68	....	52	....	240	
Mortality	0	0	3	4.4	0	0	3	1.25
Total complications	14	11.7	27	39.7	9	17.6	50	20.8
Wound complications	6	5.0	(3)	4.4	2	3.8	11	4.6
Abdominal complications	2	1.7	18	26.5	3	5.8	23	9.6
Pulmonary complications	3	2.5	1	1.5	3	5.8	7	2.9
Upper respiratory complications	1	0.8	0	0	1	1.9	2	0.8
All other complications	2	1.7	5	7.3	0	0	7	2.9
Causes of Death								
Peritonitis	...	....	2	2.9	..	....	2	0.8
Postoperative parotitis	...	....	1	1.5	..	....	1	0.4

tal with perforated appendices. Immediate postoperative complications developed in 20.8 per cent of the cases. Wound complications developed in 4.6 per cent of the cases, abdominal complications in 9.6 per cent of the cases, pulmonary complications in 2.9 per cent of the cases and upper respiratory complications in 0.8 per cent of the cases.

TABLE III

INCIDENCE AND TYPES OF IMMEDIATE POSTOPERATIVE COMPLICATIONS OCCURRING IN HEMORRHOIDECTOMIES. ANALYSIS OF 183 CASES

	Hemorrhoidectomies	
	No.	Per Cent
Total cases	183	
Mortality	0	0
Total complications	6	3.28
Wound complications	1	0.55
Abdominal complications	2	1.09
Pulmonary complications	1	0.55
Upper respiratory complications	0	0
All other complications	2	1.09

eral incidence of abdominal complications particularly ran high in the group of acute appendicitis with perforation, gangrene or abscess. The incidence of complications was 26.5 per cent and among these complications were nausea and vomiting, postoperative distention, peritonitis and pelvic abscess.

There were no deaths in the acute and chronic recurrent appendicitis groups. Three deaths occurred in the group of acute appendicitis with perforation, gangrene and abscess. Two deaths were due to postoperative peritonitis and one to postoperative parotitis.

The incidence and types of immediate postoperative complications in those cases having hemorrhoidectomy are summarized in Table III. There were 183 such cases. No deaths occurred in this group and only 3.28 per cent developed complications.

The incidence and types of immediate postoperative complications and mortality in relation to peptic ulcer pathology existing at time of operation are summarized in Table IV. There were forty-six cases in this group. The general mortality percentage in this group of cases was 19.6 and the inci-

TABLE IV

INCIDENCE AND TYPES OF IMMEDIATE POSTOPERATIVE COMPLICATIONS AND MORTALITY IN RELATION TO TYPES OF PEPTIC ULCER PATHOLOGY PRESENT AT TIME OF OPERATION. ANALYSIS OF 46 CASES. 1936 TO 1939. PHILADELPHIA GENERAL HOSPITAL

	Elective Peptic Ulcers		Hemorrhaging Peptic Ulcers		Perforated Peptic Ulcers		All Cases Peptic Ulcer	
	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
Total cases	13	....	12	....	21	....	46	
Mortality	1	7.7	0	0	8	38.1	9	19.6
Total complications	5	38.5	3	25	10	47.6	18	39.2
Wound complications	1	7.7	0	0	0	0	1	2.18
Abdominal complications	0	0	0	0	4	19.2	4	8.7
Pulmonary complications	3	23.1	2	16.7	6	28.6	11	23.9
Upper respiratory complications	1	7.7	0	0	0	0	1	2.18
All other complications	0	0	1	8.4	0	0	1	2.18
Causes of Death								
Postoperative pneumonia	1	7.7	..	....	3	14.3	4	8.7
Pulmonary embolus	..	....	..	....	1	4.8	1	2.2
Peritonitis	..	....	..	....	2	9.5	2	4.3
Subdiaphragmatic abscess	..	....	..	....	2	9.5	2	4.3

In the group of acute appendicitis with perforation, gangrene, or abscess, only those wounds which were closed without drainage and later broke down were included as wound complications. The gen-

dence of complications was 39.2 per cent. Wound complications occurred in 2.18 per cent of the cases, abdominal complications in 8.7 per cent of the cases, pulmonary complications in 23.9 per cent of the cases and upper respiratory complications in 2.18 per cent of the cases.

Abdominal complications were particularly high in the perforated peptic ulcer group (19.2 per cent). Pulmonary complications were high in all groups (23.9 per cent average), but were relatively low in the hemorrhaging peptic ulcer group.

The incidence and types of immediate postoperative complications occurring in those cases subjected to inguinal herniorrhaphy are summarized in Table v. There were 112 cases in this group. There were no deaths, but complications occurred in 13.4 per cent of the cases. Wound complications occurred in 5.35 per cent of the cases; abdominal complications occurred in 0.89 per cent of the cases; pulmonary complications in 6.25 per cent and upper respiratory complications in 0.89 per cent of the cases.

The incidence and types of immediate postoperative complications and mortality in those cases subjected to biliary tract surgery are summarized in Table vi. Three were eighty-one cases in this group. Of all these patients 11.1 per cent died and 39.9 per cent developed postoperative complications. Wound complications occurred in 2.47 per cent of the cases, abdominal complications in 11.1 per cent of the cases, pulmonary complications in 12.65 per cent

TABLE V

INCIDENCE AND TYPES OF IMMEDIATE POSTOPERATIVE COMPLICATIONS OCCURRING IN INGUINAL HERNIORRHAPHIES. ANALYSIS OF 112 CASES

	Herniorrhaphies	
	No.	Per Cent
Number of cases	112	
Mortality	0	0
Total complications	15	13.4
Wound complications	6	5.35
Abdominal complications	1	0.89
Pulmonary complications	7	6.25
Upper respiratory complications	1	0.89
All other complications	0	0

TABLE VI

INCIDENCE AND TYPES OF IMMEDIATE POSTOPERATIVE COMPLICATIONS AND MORTALITY IN RELATION TO TYPE OF OPERATIONS DONE ON THE BILIARY TRACT. ANALYSIS OF 81 CASES. 1936 TO 1939. PHILADELPHIA GENERAL HOSPITAL

	Cholecystectomy		Cholecystostomy		Choledochostomy		All Others		Total	
	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
Number of cases	45	.....	19	.....	14	.....	3	..	81	
Mortality	3	6.6	3	15.8	2	14.2	1	..	9	11.1
Total complications	19	42.2	7	38	4	28.6	2	..	32	39.5
Wound complications	1	2.22	0	0	1	7.15	0	..	2	2.47
Abdominal complications	8	17.8	1	5.27	0	0	0	..	9	11.1
Pulmonary complications	7	15.6	3	15.8	0	0	0	..	10	12.65
Upper respiratory complications	1	2.22	0	0	0	0	0	..	1	1.26
All other complications	2	4.44	3	15.8	3	21.4	2	..	10	12.65
Causes of Death										
Liver shock	1	2.22	2	10.5	1	7.15	1	..	5	6.16
Subdiaphragmatic abscess	1	2.22	0	0	0	0	0	..	1	1.26
Peritonitis	0	0	1	5.27	0	0	0	..	1	1.26
Postoperative pneumonia	1	2.22	0	0	0	0	0	..	1	1.26
Icteric toxemia	0	0	0	0	1	7.15	0	..	1	1.26

of the cases and upper respiratory complications occurred in 1.26 per cent of the cases. Of interest is the relatively high incidence of abdominal complications (17.8 per cent) and pulmonary complications (15.6 per cent) in the group subjected to cholecystectomy.

TABLE VII
INCIDENCE OF MORTALITY AND IMMEDIATE POSTOPERATIVE COMPLICATIONS IN RELATION TO ANESTHETIC AGENT. ANALYSIS OF 662 CASES. PHILADELPHIA GENERAL HOSPITAL. 1936 TO 1939

Anesthetic Agent	No. of Cases	Mortality		Complications	
		No.	Per Cent	No.	Per Cent
Gas-ether	108	2	1.85	28	27
Cyclopropane-ether	55	0	0	9	16.4
Ether	15	0	0	6	40
Cyclopropane	26	4	15.4	10	38.4
Gas (N_2O)	1	0	0	1	
Spinal novocaine	308	9	2.92	49	15.9
Spinal metycaine	11	0	0	1	9.1
Spinal pontocaine	6	0	0	0	0
Spinal nupercaine	6	0	0	1	
Spinal novocaine-cyclopropane	7	0	0	0	0
Spinal pontocaine-cyclopropane	1	0	0	0	0
Spinal nupercaine-cyclopropane	1	0	0	0	0
Spinal novocaine-gas ether	4	0	0	1	
Sacrocaudal block (novocaine)	8	0	0	0	0
Nerve block (novocaine)	2	0	0	0	0
Local novocaine	103	6	5.85	15	14.6
Total	662	21	3.18	121	18.25
All inhalation anesthetics	205	6	2.92	54	26.4
All spinal anesthetics	331	9	2.72	51	15.4
All local anesthetics	113	6	5.3	15	13.3
Combined	13	0	0	1	7.7

"Liver shock" accounting for the deaths of 6.16 per cent of the patients having a biliary operation appeared to be the most common cause of death in the cases subjected to surgery of the biliary tract.

The incidence of immediate postoperative complications and mortality in relation to the anesthetic agent use are summarized in Table VII. In considering the high mortality associated with cyclopropane (15.4 per cent) and local novocain (5.85 per cent) it should be mentioned that the poor risk patients received these anesthetics. The incidence of mortality in those patients receiving gas-ether and spinal novocain, the two most commonly used anesthetics, was very close, 1.85 per cent in the former and 2.92 per cent in the latter. There were no actual anesthetic deaths in the series of 662 cases. The mortality was due in each case to the patient's disease and not the anesthetic agent.

The incidence of immediate postoperative complications was approximately two times as high in those patients receiving gas-ether as it was in those receiving spinal novocain.

The incidence and types of immediate postoperative complications and mortality in relation to the type of anesthesia used are summarized in Table VIII. Two hundred five patients received inhalation anesthetics and of this number 2.9 per cent died and 26.4 per cent developed postoperative complications. Three hundred thirty-one patients received spinal anesthetics and of this number 2.7 per cent died and 15.4 per cent developed postoperative complications. One hundred thirteen patients received local anesthetics and of this number 5.3 per cent died and 13.3 per cent developed complications.

It is interesting to note that the incidence of wound complications was approximately two times as high in those cases getting inhalation anesthesia as it was in those cases getting spinal or local anesthesia. Abdominal complications were about equally divided among those receiving inhalation anesthesia and those receiving spinal anesthesia. In those cases receiving inhalation anesthesia the incidence of respiratory complications was approximately three times as high as in those cases receiving spinal anesthesia. The respiratory complications occurring with inhalation anesthesia were acute bronchitis (four cases), postoperative atelectasis (ten cases), postoperative pneumonia (three cases), and pulmonary infarct (two cases). Two of the patients developing pneumonia eventually died. Respiratory complications occurring in those cases receiving spinal anesthesia were postoperative atelectasis (five cases), postoperative pneumonia (five cases), and pulmonary embolism (one case). Three of the patients developing pneumonia and the patient developing pulmonary embolism eventually died.

Analysis of the 662 cases in regard to immediate postoperative complications and mortality relative to age by decades was made. The incidence of complications remained practically constant through the decades to the seventh decade (60 to 69) in which there was somewhat of a rise in incidence. Abdominal complications appeared to be relatively higher in the first, fifth and seventh decades. The incidence of postoperative pulmonary complications and wound complications remained practically constant through the various decades. The incidence of mortality was increased in the fifth decade and above. In general we were unable to find any variation of significance in the types or incidence of complications in the various age groups.

TABLE VIII

INCIDENCE OF MORTALITY AND IMMEDIATE POSTOPERATIVE COMPLICATIONS IN RELATION TO ANESTHESIA USED. ANALYSIS OF 662 CASES. 1936 TO 1939. PHILADELPHIA GENERAL HOSPITAL

	Inhalation		Spinal		Local		Combined Inhalation and Spinal		Total	
	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
Total cases	205	.....	331	.....	113	.....	13	..	662	
Mortality	6	2.9	9	2.7	6	5.3	0	0	21	3.18
Total complications	54	26.4	51	15.4	15	13.3	1	..	121	18.25
Wound complications	10	4.88	7	2.12	3	2.66	1	..	21	3.17
Abdominal complications	14	6.86	21	6.35	4	3.54	0	..	39	5.9
Pulmonary complications	19	9.27	12	3.63	5	4.43	0	..	36	5.44
Upper respiratory complications	5	2.44	1	0.3	0	0	0	..	6	0.9
All other complications	6	2.83	10	3.02	3	2.66	0	..	19	2.86
Causes of Death										
Liver shock	1	0.5	1	0.3	3	2.7	..	..	5	0.75
Peritonitis	2	1	1	0.3	2	1.8	..	..	5	0.75
Subdiaphragmatic abscess	1	0.5	1	0.3	1	0.9	..	..	3	0.45
Postoperative pneumonia	2	1	3	1.5	...	.....	..	..	5	0.75
Pulmonary embolus	...	.....	1	0.3	...	.....	..	..	1	0.15
Postoperative parotitis	...	.....	1	0.3	...	.....	..	..	1	0.15
Icteris toxemia	...	.....	1	0.3	...	.....	..	..	1	0.15

REMARKS

In most cases the patients coming to this large charity hospital are poorly nourished and deficient in vitamins. They are usually below the average mentally and usually do not come to the hospital until their pathological condition is far advanced. It is possible that these factors may play some part in the relatively high incidence of mortality and immediate postoperative complications in some of the more severe operations studied.

SUMMARY AND CONCLUSIONS

1. Certain facts concerning the immediate post-operative complications and mortality in 662 consecutive surgical cases coming to the Philadelphia General Hospital from January 1, 1936 to July 1, 1939 are presented.

2. The surgical procedures considered were appendix surgery (240 cases), peptic ulcer surgery (forty-six cases), hemorrhoid surgery (183 cases), biliary tract surgery (eighty-one cases), and inguinal hernia surgery (112 cases).

3. Of particular interest is the relatively high incidence of postoperative pulmonary complications in the patients receiving inhalation anesthesia as compared to those receiving spinal anesthesia.

THE ANATOMY OF THE SPHINCTER OF ODDI*

NORMAN W. THIESSEN, M.D.
Assistant in Surgery, Western Reserve University, School of Medicine
CLEVELAND, OHIO

THE structure of the musculature surrounding the intramural portion of the common bile duct has been studied extensively by various methods. Reconstructions have not been attempted because of the complex structure of the adult muscle pattern. It was believed, therefore, that even if the result of such an attempt were not entirely accurate, it might prove to be valuable for demonstration purposes. The reconstruction model is here presented and discussed.

LITERATURE

The earliest mention of the anatomical relationship of the choledochoduodenal juncture is credited to Vesalius.[1] In 1543, discussing the ideas prevalent at the time, he stated that by dissection it was learned that "not the smallest part of the bile vesicle was extended into the stomach." He also described the valvular nature of the longitudinal folds preventing regurgitation into the biliary tract.

Fallopius,[2] in 1561, emphasized the oblique course of the duct through the intestinal wall, but Glisson,[3] in 1654, was the first to suggest the existence of a sphincteric mechanism at the lower end of the common duct. He believed that the sphincter existed only to prevent regurgitation of chyme and that the regulation of the flow of bile into the intestine was accomplished by a separate sphincter around the neck of the gallbladder. Bianchus[4] about 1711 in his book "Historia Hepatica" first postulated the idea that the sphincter at the outlet of the common duct was concerned with the flow of bile.

Following this observation there seems to have been little done until Luschka,[5] in 1869, studying the pars intestinalis of the common bile duct in man, found no separate smooth muscle fibers around the common duct. In 1879, Gage[6] described the existence of a sphincter in the cat.

Then in 1887, Oddi[7] investigated the intramural portion of the common bile duct in animals by histological means. He described "a more or less pronounced bed of circular fibers encircling the choledochal canal, which one is able to consider as almost completely independent, if one excepts some slender loops which lose themselves between the fibers proper of the intestine."

Znaniecki,[8] in 1895, studied cross sections of the choledochoduodenal juncture and described a definite arrangement of smooth muscle fibers separate from the muscularis mucosae and the other duodenal musculature.

Hendrickson,[10] in 1898, reported gross and microscopic studies of the extrahepatic biliary system of the dog, rabbit and man. He concluded that transverse, longitudinal and diagonal muscle fibers can be found in all parts of the biliary system in each species and that a definite sphincter of Oddi exists in all three.

Letulle and Nattan-Larrier[11] and Helly[12] further described the anatomical arrangement of muscle bundles.

Stöianoff[13] investigated the biliary passages in the dog and concluded there was no true sphincter at the terminal end of the ductus choledochus, unless the fibers of the circular muscle layer of the duodenum were regarded as such.

Various investigators (Stracker,[14] Broman,[15] Rost,[16] Mann,[17] Auster and Crohn,[18] Matsuno,[19] Westphal,[20] Nagai and Sawada,[21] Burget,[22,23] Job[24]) have studied the musculature of the choledochoduodenal

* From the Laboratory of Surgical Research, Western Reserve University, Cleveland, Ohio.

juncture in many types of animals and man. The descriptions even in the same animals vary, although all agree as to the presence of muscle bundles capable of sphincteric activity.

In the guinea pig and opossum the ampulla is distinct from the duodenal wall and has its own smooth musculature.[25,26,27] This suggests that perhaps the relationship between these muscle fibers may be only a phylogenetic stage resulting in higher animals in a blending of the two groups to such an extent as to make separate identification questionable.

Giordano and Mann,[28] in 1927, reviewed these findings and reported further studies on the intramural portion of the common duct in more than twenty species of animals. They concluded that while variations in species and individuals of the same species occur frequently, "it is usually possible to find a definite bundle of smooth muscle surrounding the common bile duct, contractions of which would tend to close the lumen."

Nuboer[32] and Porsio[29] both described muscle arrangements in man which derived from the circular muscle of the duodenum, but which were so arranged as to act as a sphincter.

Schwegler and Boyden[30] again investigated the anatomy of this region by studying the appearance and development of the smooth muscle fibers in successive embryonic stages. They concluded "that all constituents of the sphincter of Oddi (except, perhaps, the X fibers of Hendrickson) are of mesenchymal origin, that is, they develop as a true musculus proprius of the ducts."

Kreilkamp and Boyden[35] dissected twelve adult specimens of the choledochoduodenal juncture by a new maceration technic. They found a well developed sphincter pancreaticus in only four and a sphincter ampullae in only two of the group. They suggested that anatomical variations are important factors in the pathological physiology of the biliary tract.

A historical summary of the many anatomical investigations on this important region will allow one general conclusion. The greater weight of evidence supports the existence of variable amounts of smooth muscle tissue in animals and man which, regardless of origin, may possess sphincteric activity at the outlet of the common bile duct.

METHOD

Heretofore, three methods have been employed to study the musculature of this region. The study of serial sections was done first by Gage in 1879. Oddi also used this method, as did many others. There are several objections to this method. Even when specific smooth muscle stains are used, individual interpretations vary. Furthermore, gradations in structure are visualized only with difficulty. A second method is the use of maceration preparations. This procedure was first employed by Oddi[7] and then by Hendrickson[10] (1898). This method destroys part of the structure so that comparisons are again relatively inaccurate. Recently, however, Kreilkamp and Boyden[35] have described a perfected maceration technic consisting in alternately hardening and softening the specimen during dissection, which seems to obviate some of the objections to the older method. Schwegler and Boyden[31] studied serially sectioned embryos of various ages and reconstructed the developing musculature before it became complex. Three dimensional reconstructions have not been attempted because of the complexity of the muscle pattern. However, despite the obvious technical problems involved, an attempt has been made to reconstruct the smooth muscle surrounding the choledochoduodenal juncture in man.

The specimen from which the reconstruction was made was obtained at necropsy from an adult male who died of disease unrelated to the biliary system. At the necropsy table a piece of small caliber glass tubing was inserted through the ampulla so as to maintain the architectural relationships during the fixation process. The

specimen was trimmed down so that the final length was about 1 cm. After the tissue had been hardened in formalin and prepared for embedding in paraffin, the glass tubing was replaced by a similar tube of paraffin. The presence of the tube compressed the mucosal villi together to a small extent, but a study of the completed sections showed the distortion of the muscle bundles to be negligible. After embedding in paraffin, serial sections were cut and stained according to Van Gieson's method. In the usual type of reconstruction work it is customary to use each or every other section. It was readily apparent in the present work that if this were done and sections 1 mm. thick were used, the resulting model of a sufficient length of the choledochoduodenal juncture to demonstrate relationships would result in a reconstruction more than 2 feet in length. Accordingly, each section was cut 10 micra thick and every fifth section used. In this way a sufficient amount of muscle tissue was visualized to allow adequate study of its relationship. The sections were then studied microscopically and camera lucida drawings of the smooth muscle bundles made, using the lumen of the common bile as a center "core." The complexity of the muscle pattern was such that strict reproduction of all the minute variations in structure from slide to slide was not practicable. The pictures obtained were already so intricate that no attempt was made to separate longitudinal from circular muscle fibers. Because of this, certain arrangements of these two muscle layers which have been shown to exist cannot be demonstrated in the model.

The musculature was then reconstructed in wax, using the Born method. It was found that the wax model not only sagged where the structure thinned out, but narrow corners and edges chipped off. In addition, the model was too fragile to handle easily, so demonstration of any but the outside surfaces could not be carried out. The possibility of casting the model out of some more durable material was considered and several experts in industrial casting and die-making were consulted. None of them would promise any result and the process of casting the structure would destroy the original model. Then an attempt was made to coat the outer side of the model with some metal; a rough sample model of similar shape and material was coated with graphite and sprayed with aluminum paint. The result was not successful. As a final alternative the reconstruction process was repeated, using a pliable aluminum sheeting instead of wax plates. Aluminum was chosen because of its light weight and its relatively low cost. The resulting model is durable, may be handled with relative ease and will never change shape or become brittle as with wax models. When finished, the model was bisected with a band saw. The muscle component was painted red and the center core, representing the lumen of the common duct, painted black. The transverse magnification as computed by stage scale comparison and measurement is 75, and the vertical magnification due to the use of every fifth section is 20.

OBSERVATIONS

In the following description the term "distal" refers to the intestinal end of the common bile duct, and "proximal" to the portion of the common duct extending up to the liver.

The Choledochal Window. The base of the model represents the portion of the musculus proprius of the common bile duct at the hiatus through the muscle coats of the duodenum. This opening or break in the muscles has been designated the choledochal window.

The first sections are composed of curving arcs of muscle which in the beginning do not encircle the common duct completely, but fuse more distally, leaving no very large openings. These few sections, representing about 3.0 mm. of the original specimen are the distal limits of the muscle bundle designated by Schwegler and Boyden as the "pars superior of the sphinc-

ter choledochus" or "sphincter choledochus superior." (Figs. 1, 2, 3.) Hendrickson demonstrates them in Figure 32 of his original article, but does not mention them in the text. In the model this mass of muscle is quite irregular, part of it continuing around the common duct and part passing in closer to the common duct to connect toward the ampullary end with the sphincter choledochus inferior. (Fig. 1.) This maze of fibers represents the "R" and "C" fibers recently described by Kreilkamp and Boyden. These investigators have described as reinforcing or "R" fibers those strands of circular or longitudinal muscle of the duodenum which separate at the choledochal window to encircle the common duct in both directions and are continuous with similar strands from the other side at the same and different levels. These "R" fibers represent, they believe, postnatal development of the X 1, 2, 3, fibers (Hendrickson, Schwegler and Boyden). In addition to these there are connecting or "C" fibers, which originate similarly, but branch over from the duodenal longitudinal fibers to unite with the musculus proprius of the common duct.

On one side of the model off-shoots are clearly shown which probably represent the connecting fibers with the duodenal musculature. This blending of muscle fibers is so intimate in places that on the mucosal side of the model the thickness of the muscles is due partly to the difficulty in separating the two muscle systems when making the camera lucida drawings. The outer portion of this band of fibers represent the "K" fibers of Hendrickson or "C" fibers of Kreilkamp and Boyden. (Fig. 3.)

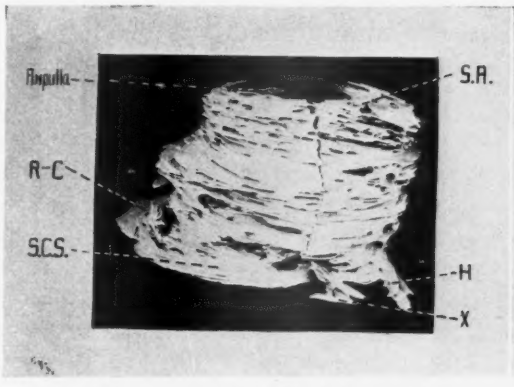

Fig. 1. The pancreatic side of the muscle system. R-C reinforcing and connecting fibers; S.C.S., sphincter choledochus superior; H, "H" fibers surrounding pancreatic duct; X, "X" fibers at choledochal window.

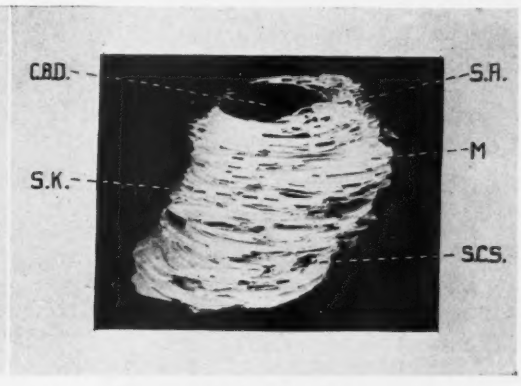

Fig. 2. The mucosal side of the muscle system. C.B.D. the lumen of the common bile duct; S.K. circular and longitudinal fibers; S.A., sphincter ampullae; S.C.S., sphincter choledochus superior; M, the level at which duodenal muscle entirely disappears.

On the pancreatic side of the model angled bits of muscle appear which develop into a shape like a cocked hat. These are the longitudinal "X" fibers of Hendrickson (Fig. 29 of his article), or "R_2" fibers of Kreilkamp and Boyden (Fig. 1, their article). It is interesting to compare these pictures with the illustrations of Nuboer (Fig. 14) and Schwegler and Boyden (Fig. 12, article 3). These fibers appear to anchor the bile duct to the choledochal window and by contraction to shorten the duct. Matsuno states that they may be distinguished from the intestinal muscles by the reduced width of their fibers. Schwegler and Boyden state that embryologically they develop both from the musculus proprius of the ducts and the intestinal muscle. Kreilkamp and Boyden support this statement by demonstrating muscular connections between them. Whatever their origin, they are important muscle fibers, since they definitely unite the two sets of muscles.

Musculus Proprius Ductus Pancreatici. The nomenclature used is that of Schwegler and Boyden. In the model just distal to the

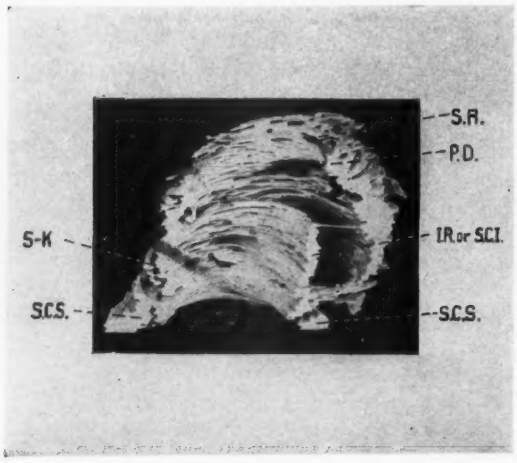

FIG. 3. The common bile duct lumen of the bisected model has been removed. S-K, circular and longitudinal fibers. S.C.S., sphincter choledochus superior; S.A., sphincter ampullae; P.D., pancreatic duct; I.R., or S.C.I., independent ring or sphincter choledochus inferior; S.C.S., choledochus superior.

"X" fibers and connected to them, muscle bundles arranged in a semicircular manner are seen on the two sides of the pancreatic duct as it approaches the bile duct. Hendrickson designated these as "H" fibers. (Fig. 1.) These fibers gradually approximate so that in two areas the duct of Wirsung is completely encircled. (Fig. 3.) The muscle then frays out on the mucosal side of the duct. The other half of the muscle elongates and finally unites with the fibers coming from the other side of the bile duct. Nuboer states that "the muscle mantle around the D. pancreaticus has in the main the same structure as that around the D. choledochus," and that just before the union of the two ducts "the muscle of Oddi lies around both ducts in such a way that a figure-8-shaped structure arises." (Fig. 16, his article.) (Fig. 3.) Schwegler and Boyden disagree with this statement, saying that in fetal stages "only a few insignificant circular fibers on the sides of the pancreatic duct swing around between the two ducts." In Figure 16 of part III, Schwegler and Boyden illustrate such circular fibers branching over. In the model in several areas circular fibers and Nuboer's "figure 8" arrangement are present. These fibers are so small and infrequent in comparison to the total mass of the muscles and to the longitudinal fibers present that at least in this specimen one must agree with Schwegler and Boyden. In adults, Kreilkamp and Boyden found a well developed sphincter pancreaticus in only four of twelve specimens, but usually these fibers do not appear strong enough to exert any important sphincteric action upon the pancreatic duct. Since most of these fibers are longitudinal, their function in the majority of individuals is more probably that of shortening the duct.

The Sphincter Choledochus Inferior. Hendrickson named this sheath of muscle fibers surrounding the common bile duct from the choledochal window to the juncture of pancreatic and bile ducts the "independent ring," differentiating from it the "S" or "sphincter" fibers which are continuous with it, but situated lower down on the mucosal side of the bile duct. (Figs. 29 and 30, his article.) Schwegler and Boyden found the muscle continuous in several fetuses (Fig. 6, part I, Fig. 8, part III) with the sphincter choledochus superior and suggested a more appropriate name would be the "pars inferior of the sphincter choledochus."

In this reconstruction this muscle bundle is about 5.25 mm. in length. (Fig. 3.) It has interruptions in its circumference but in the main is a continuous sheath of circular muscle fibers. Nuboer, and Schwegler and Boyden describe it as reaching its greatest development just before the ampulla. However, Schwegler and Boyden refer to an illustration in which the separation of the pancreatic and bile ducts is clearly shown in cross section, indicating that that area is an appreciable distance from the juncture of the two ducts. In this model the greatest thickness of this muscle is some 3 to 4 mm. from the juncture of the two ducts.

Despite the fact that this muscle was called the "independent ring" by Hendrickson, it is not an entirely separate

muscle system. In numerous places on the mucosal side of the ducts these fibers blend with the "S" fibers. (Fig. 3.) The model shows these fibers as one muscle mass. Indeed, as Boyden[34] points out, Hendrickson's "S" fibers are merely the mucosal side of a continuous sphincteric sheath which proximally is sphincter choledochus and distally is sphincter ampullae. Kreilkamp and Boyden found a well developed sphincter choledochus in all twelve specimens they examined. In any event, however, here exists a sufficiently separate muscle sheath which by contraction will close the common bile duct without effect on the pancreatic duct. This is the muscle which in pathological states causes the clinical condition known as biliary dyssynergia or dyskinesia. To postulate that these muscle fibers undergo pathological change independent of the other fibers appears questionable. It is more probable that all the fibers are equally affected and this ring is the only muscle mass so placed as to lead to clinical symptoms by its change.

The Musculus Proprius Ampullae. At the point where the duodenal musculature disappears there exists a definite thickening of the muscles, confined mostly to the pancreatic side. (Fig. 2, M.) Schwegler and Boyden in Figure 8, part III, also picture a thicker muscle on one side of the ampulla in a 52.5 cm. fetus. The reason for this is not apparent. It is at this point that many of the circular fibers become longitudinal. This would explain the sudden rather marked thinning out of the muscles distal to this area, but not the local thickness. It may be an attempt to fix this point at the last place where duodenal muscle is present. In this specimen the duodenal muscles separate entirely from the sphincter fibers about 3.25 mm. from the end of the ampulla and disappear 1.8 mm. proximal to the last sphincter muscle fibers. From the point of complete separation of the duodenal musculature and the musculus proprius out to the end of the papilla the muscle thins out, first on the mucosal side and then frays out rapidly on the pancreatic side to disappear about 2.25 mm. from the end of the plicae longitudinalis. This muscle has been called the musculus proprius ampullae. (Figs. 1, 2 and 3.) Most of these fibers are longitudinal (X, K, H, S fibers), but circular fibers do exist, arranged in semicircular arcs partially encircling the bile duct. In the great majority of individuals it is evident that these fibers, while capable of sphincteric action, are much weaker than those farther back. It is doubtful, therefore, that their action can obstruct the flow of both the bile and pancreatic juice.

The ampulla in this specimen was of average depth. The first muscle tissue appeared 2.25 mm. from the end of the plicae longitudinalis, while the center of the junction of the pancreatic duct with the common duct was 1.5 mm. proximal to that point. These distances are probably more than the actual distances due to the cutting of the specimen on an oblique plane. The first complete ring of tissue occurs at the same place where the first muscle appears, so the ampulla is probably not more than 2 mm. in depth in this specimen.

Giordano and Mann[28] have shown that in 76 per cent of autopsies the ampulla was 2 mm. or less in length. Nagai and Sawada[21] reported the average depth as 5 mm. On the other hand, Job[24] found an ampulla in only eight of 151 specimens. Baggenstoss[33] collected a thousand cases from the literature and reported that in 43 per cent no ampulla was found, while in many of the others the juncture of the ducts occurred not more than 1 to 2 mm. back of the apex of the ampulla.

There seems to be little doubt but what anatomical variations are important contributing factors in the production of clinical syndromes referable to this area. Thus, Kreilkamp and Boyden found a well developed sphincter ampullae in but two of twelve adult specimens. Giordano and Mann state that in approximately 20 per cent of patients reflux of bile into the duct of Wirsung is theoretically possible. These figures have been substantiated by the

cholangiographic studies of Leven,[36] and Colp and Doubilet.[37,38] Clinically, it is interesting that about 25 per cent of patients with duodenal ulcer have associated biliary disease, suggesting that contiguous inflammation of a strong sphincter ampullae is the possible inciting agent.

It seems significant that all these percentages are approximately the same, suggesting that a strongly developed sphincter ampullae is the basic anatomical cause for the symptoms in this group of patients.

SUMMARY

A three-dimensional reconstruction of the intrinsic musculature surrounding the end of the common bile duct in man, generally referred to as the sphincter of Oddi, is presented. Here is visualized grossly for the first time the structure of the muscles in this important region in the adult human. A separate circular sheath of muscle is seen which by contraction can cause the clinical picture known as biliary dyssynergia. The model substantiates in the main and visualizes in three dimensions the findings reported by Hendrickson, Nuboer, Schwegler and Boyden, and Kreilkamp and Boyden.

Sincere appreciation is expressed for the encouragement and technical advice given by Dr. S. W. Chase, Associate Professor of Histology and Embryology, Western Reserve University, and to John F. Timmons.

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Sterilization means . . . the cutting of the spermatic duct in the male, a minor and easily accomplished operation, and the tying-off and cutting of the fallopian tubes in the female, a difficult operation but still not in the class of the major or dangerous procedures.
From—"The March of Medicine"—New York Academy of Medicine (Columbia University Press).

PERIPHERAL ARTERIAL OCCLUSION*

GRANT P. PENNOYER, M.D.
Associate Attending Surgeon, Roosevelt Hospital
NEW YORK, NEW YORK

THIS report is based upon experience gained in a special clinic which has been conducted for over six years at Roosevelt Hospital for the diagnosis, study and treatment of arterial disease of the extremities. It is not an attempt to review the subject, but simply an analysis of some salient features which have impressed me personally during the observation of these cases.

The most valuable contribution of such a clinic is early recognition of peripheral arterial disease. The process can and should be recognized in its early stages, long before the damage is severe enough to cause serious disability. Very few doctors in doing a general physical examination are sufficiently interested in the arteries of the legs and feet. The disease can be detected, frequently, years before any clinical symptoms develop. The margin of safety in the peripheral circulation is so great that even mild clinical manifestations may be late in the pathologic process, and gangrene, though often the first condition for which the patient asks treatment, is an extreme end result. Consider the circulation of the lower extremity of the young athlete capable of running a mile in less than five minutes, and compare it with the condition in which the circulation is so reduced that the basic nutrition of the tissues cannot be maintained. The contrast is amazing. Based upon quantitative metabolism studies, it is probably reduced to less than one-half of 1 per cent.[1] The functional capacity of the circulation very much exceeds the requirements of the basic nutrition of the tissues. The reason for this is obvious when one considers that the peripheral circulation is designed to meet, with a margin of safety, many functions in addition to simple nutrition, such as the regulation of body heat, the supply of muscle energy and the mobilization of resistance to infection —any one of which may require at times a much larger amount of blood than the basic nutrition of the tissues. The usual case of arteriosclerosis and thrombo-angiitis obliterans progresses slowly over many years so that it should be possible to detect the process in the preclinical stage. Early subjective symptoms, such as easy chilling and fatigue, burning and tingling of the feet and slight muscle pain after unusual effort may not result until the pathologic process is of long standing. Even when symptoms are well established, these cases are frequently incorrectly diagnosed as flat feet, muscle strain, arthritis, neuritis or rheumatism. They are operated upon for an ingrown toenail or a painful callus, or perhaps injected for varicose veins, sometimes with disastrous results. A department in the hospital where the condition of the peripheral arterial circulation can be accurately appraised serves a very useful purpose. Every diabetic patient should be periodically examined and accurate records made of the condition of the circulation. Even in advanced cases in which little can be done to improve the situation, it is of great help to the patient and to the doctor to know the facts.

Patients without gangrene or open lesions can be taught how to get along comfortably with their limitations and how to prevent progression and complications. A simple routine is all that is necessary for this in most cases. During the last six years only one patient has come to major amputation who had presented himself to

* From the Vascular Clinic of Roosevelt Hospital, Dr. Grant P. Pennoyer, Director.
Read before the New York Surgical Society, May 8, 1940.

the clinic before open lesions or infection had set in. Salient features of this routine are mental and physical rest, very warm clothing for the entire body even in mild weather, including long woolen underwear, woolen stockings and high, soft orthopedic shoes. Abstinence from smoking is essential for the arteriosclerotics as well as the Buerger cases. I do not believe a diabetic, even though he has no arterial occlusion, should be allowed to smoke. The rate and amount of walking and all activity is kept below the level of muscle pain. I am very explicit in my advice as to the care of the feet. I insist that they be bathed morning and evening in lukewarm water with castile soap and the nails scrubbed with a soft brush. Exact directions are given as to how the nails should be cut and the type of stockings and shoes to be worn. Corns and diseased nails are cared for by the doctor.

For the ambulatory cases without open lesions, I am very skeptical as to the permanent value of any type of physiotherapy treatment, medication, injections or special diets. These people are chronic sufferers whose symptoms are often helped by most any treatment. They are encouraged by and very appreciative of all attention. Subjective improvement is very common by every method of therapy, but I doubt if anything known affects appreciably the arterial capacity in cases of arteriosclerosis or thrombo-angiitis obliterans. I have never been able to demonstrate any considerable objective improvement after popular methods of treatment, such as vacuum-pressure therapy, intermittent venous occlusion, hypertonic saline infusions or injections of pancreatic and other tissue extracts. Drugs have only a fleeting effect at best. The thrombo-angiitis cases occur in much younger people, and those who have come to the clinic while there is still a fair circulation and have followed instructions carefully, have done exceptionally well during my period of observation. The diabetic arteriosclerotic patients are the most discouraging group.

The normal control of the circulation, that is the mechanism of regulating the supply of arterial blood to the demand, needs much elucidation. The emphasis in the literature and in the minds of clinicians has been placed on the control by the nervous system through the autonomic nerve supply. As is well known, this is accomplished through nerve cells in the spinal cord which connect by preganglionic fibers to the sympathetic ganglia, in which the impulses are relayed to postganglionic fibers which join the peripheral nerves to be distributed to the blood vessels. The nervous system via these sympathetic ganglia maintains a definite vascular tone which is usually symmetric. It is concerned with the regulation of body temperature, much of the heat radiation being from the extremities. It is sensitive to emotions, such as anger, worry and embarrassment. Excess body heat and mental peace are good eliminators of the vasospastic element of vascular trouble. A warm climate is of great help, as even a cold wind in the face may induce reflex vasoconstriction.

However, this reflex nervous control is not the only regulator of the arterial circulation of the extremities. The major adjustment of the arterial supply to the demand is through the metabolite control, largely, if not entirely independent of the nervous system.[1,2,3] This subject was well brought out in the 1935 Harvey Lecture by Anrep.[2] There is something in the end products of the metabolism of the tissues which causes vascular dilatation. This is probably some histamine-like substance and carbon dioxide. Thus, if a muscle or any tissue is put into increased activity, the accumulation of its own metabolites causes vasodilatation to supply the increased blood demand. The blood supply of a muscle or any tissue is automatically regulated by the speed of its metabolism, a process having no relation to the nervous system.[2]

This is the mechanism and stimulus of the development of collateral circulation.[3] If the normal arterial blood supply is cut off to any given area, the collection of the

tissue metabolites which results from the arrest of the circulation causes local dilatation of the remaining anastomosing channels. Thus, an area of increased vascularity results, and blood is automatically brought to the area by the available routes which are still intact. Even in recent medical literature one still finds occasional mention of the old increased pressure theory of collateral circulation, the idea being that if a large arterial highway is shut off, the resulting increase in blood pressure dilates the remaining channels.[4] This is quite erroneous. Pressure has little or nothing to do with the development of callateral circulation. Very extensive arterial occlusion of the extremities does not affect the blood pressure. In my experience, a low blood pressure is found in most cases of thrombo-angiitis obliterans and in many cases of arteriosclerosis with very advanced peripheral occlusion.

This metabolite control of the circulation, when the nutrition of tissues is impaired, puts in abeyance the control by the sympathetic nervous system.[1,2,3] The reactive hyperemia test of the spastic element in the peripheral circulation depends on the predominance of the metabolite control.[3,5,6] If the arterial circulation is cut off by a tourniquet for a few minutes, an oxygen debt and metabolite accumulation are created in the tissues, which in the normal leg gives a vasodilatation and hyperemia as soon as the tourniquet is released. The degree of hyperemia has been established within certain limits to be in direct quantitative proportion to the degree of oxygen debt.[5,6] The vasomotor tone of the nervous system is temporarily suppressed by the local metabolite control. When the arterial circulation is so diminished that gangrene is imminent, all demonstrable vasomotor tone is abolished in nature's effort to preserve the tissues. In this condition, vasospasm no longer plays a part. I, personally, have yet to see gangrene in arteriosclerosis or Buerger's disease in which arterial spasm from the nervous system was an appreciable factor. I am well aware of the fact that considerable medical literature and tradition are not in accord with me in this.

When the circulation is arrested and gangrene is imminent, there is marked vasodilatation to the point of paralysis of all the capillaries and arterioles which become filled with deoxygenated blood. This is the cause of the familiar congested purplish color of the feet in these cases. When the feet are held down they have the same cyanotic congested appearance as the dependent portions of a fresh cadaver. When the part is elevated and sufficient time is allotted for the paralyzed vessels to empty by gravity, the ischemic skin becomes the light lemon-yellow color seen in the morgue. As a matter of fact, the condition of the circulation closely approaches that of the cadaver. In both, all vasomotor tone is gone and the circulation arrested.

The paralysis of the capillaries and arterioles due to the local accumulation of metabolites explains phenomena observed in the peripheral vascular clinic, the mechanism of which was formerly unknown. The change in color of the feet in the dependent and elevated positions, I have just mentioned. Close observation of this appearance of the skin of the extremities in the two positions in a warm room becomes a circulatory test of great value. It is significant if a very faint pink blush of oxygenated blood remains in the skin of the toes after the foot has been elevated above the heart level for several minutes. This blush should disappear on pressure and then slowly return. This means some oxygenated blood is entering the dilated capillaries against the force of gravity and gangrene is not imminent even if it seems inevitable and the oscillometric readings are zero. It is important that the foot be warm in making this test. One can sometimes obtain this sign when the symptoms and physical findings indicate that the circulation is practically gone. In the extremity suddenly shut off from its main arterial circulation by a large embolus, huge areas of ecchymosis, blebs and in-

tense inflammation appear in the zone of borderline viability. This is a result of the extreme vasodilatation occurring automatically from the metabolite accumulation in tissues still viable but deprived of their circulation. All vasomotor tone is abolished and the capillary paralysis results in diapedesis of red blood cells and extravasation of serum. This phenomenon in varying degrees is very common in peripheral vascular occlusion of all types.

One can deduce from these facts the value of most of the sympathetic nervous system surgery in the ordinary case of arteriosclerosis and thrombo-angiitis obliterans. A considerable rise of the temperature of the skin of the feet resulting from some form of nerve block, is considered by many an indication for sympathetic nerve surgery on account of vasospasm, or vasotone, as I prefer to call it.[7,8,9] A study of the temperature of the extremities before and after blocking the nerve supply does give an indication of the degree of vascular tone maintained by the nervous system. However, this rise in skin temperature is very marked in the normal individual, and is not an indication for extensive surgery. It must be proved: First, that this vascular tone is abnormal; that it is the cause of the trouble; and, also, that it cannot be abolished in some much simpler manner. Frequently heat applied to the trunk will cause as much temperature rise in the feet as sympathetic block, and why resort to surgery if woolen underwear will accomplish as much? I particularly object to considering an indication for surgery the elevation of the cutaneous temperature resulting from an intravenous injection of typhoid vaccine.[7,10] Here, the change may be due to many other factors besides release of vasotone, such as increased blood temperature, increased heart output and changes in the blood itself. The same type of objections pertain to using as a test the effect of an intravenous injection of sodium nitrite.[11]

Cases showing a rise of skin temperature after nerve block are those with an arterial system still elastic enough to be capable of improvement and are, therefore, the best group for any method of therapy. An increase of temperature means dilatable arteries and a favorable prognosis by nonsurgical treatment. The more marked the rise, the more elastic the arteries, and the more favorable the outlook. Good results after sympathectomy must, therefore, be interpreted with great caution. This is particularly true of the group who have had some recent episode, such as an embolus, infection or sudden thrombosis of a major arterial trunk, processes frequently superimposed on chronic vascular pathology. These cases will often improve spontaneously when the condition seemed hopeless for a considerable time. If dilatable arteries are still present in an area of arrested circulation, the metabolite control will give maximal dilatation, and the elastic artery on which increased demands are put will gradually hypertrophy over many months of time.[3] I have had an opportunity to follow nine cases which have had sympathetic nerve block. Five of these fall in the thrombo-angiitis obliterans group and four in the arteriosclerotic. Judging by the absence of sweating and the measurement of skin temperatures, I believe the operation had been well performed. I could not see that the course of a single one of these patients differed in any way from the usual one without surgery. Several others had had the Leriche type of periarterial sympathectomy, which I also consider of no value. Mention is made recently in the literature of sympathetic nerve block being performed to secure a hot, dry skin to cure certain special cases of athlete's foot.[7,12,13] Many patients are operated upon just to be sure there is no element of arterial spasm. I recently heard of a woman without any arterial occlusion symptoms having a bilateral lumbar sympathectomy performed to cure an unsightly cyanosed appearance of her feet which appeared on bathing in cold water. These seem to me extreme samples of surgical enthusiasm.

Temperature studies of the feet are important. I have found the temperature of the feet in most of the advanced cases of arterial occlusion approximately that of the environment regardless of any nerve block. The feet in these unfortunate individuals are like a cold-blood animal, in that they assume practically the temperature of the surroundings and adjust their metabolism to this temperature.[14] Therefore, in treating advanced cases with open lesions and pain, the temperature control is very important. The feet are kept in a bed cradle in which the temperature is kept about 92°F., by a thermostat which is about the temperature of the normal extremity. No method of treatment contributes more to the comfort of these patients than this simple device. The leg assumes almost the same temperature as the atmosphere of the cradle. If it is higher than 92°F., the local metabolism is elevated; this increases the discrepancy between tissue demand and blood supply and causes pain.[14,15] Even a rise of one or two degrees may start burning pain in a leg which has been previously perfectly comfortable. A diminution of temperature below 90°F. brings in some vasospasm as the direct result of chilling and likewise leads to discomfort. It is not at all uncommon to have patients with gangrene, who have been unable to sleep because of excessive pain despite large doses of a very strong sedative, rest comfortably without medication as soon as the thermostat control of the temperature to 92°F. in the bed cradle is instituted. I have seen this simple device straighten out many elderly people who were formerly completely exhausted by pain and depressed by excessive sedative medication.

Very few of my patients, even with extensive gangrene, who are kept in these cradles at constant temperature, require any sedative medication. If pain suddenly recurs, one usually finds that something has gone wrong with the thermostat. I consider the thermostatic control of the temperature of the bed cradle one of the greatest contributions to the therapy of these cases. Its very simplicity leads some physicians to ignore it. Hot water bags, heating pads and even baking machines are still employed on these cases. No form of heat should ever be employed except heat thermostatically controlled. In addition to causing pain, the danger of burning is very great. The cutaneous sensation in severe cases is very dull or completely absent, so that the patient has no warning of the damage. In addition, there is no circulation to conduct away the heat. A hot water bag which feels just comfortably warm on the skin of the face may cause a bad burn to the feet of these patients. The intact circulation tries to keep the skin cool in the presence of excess heat, just as it tries to keep it warm in the presence of cold. If the circulation is arrested, the full heat of the hot water bottle is gradually transmitted to the skin which is blistered by a temperature which feels perfectly safe to the most careful nurse. Diathermy, heat lamps, ultra-red and baking machines are particularly bad. In addition to burning, the excess heat may precipitate a gangrenous process by increasing the discrepancy between the blood demand and blood supply.[14]

Another most important consideration in treating an advanced case of peripheral arterial occlusion is absolute, prolonged body rest. Active muscles require much more circulation than the basal metabolism of the tissues. This is easily demonstrated by quantitative metabolism studies.[1] When the blood supply is so reduced that even the basic nutritional need of the tissues is endangered, all other demands on the circulation must be eliminated as completely as possible to allow the remaining circulation to be used solely for nutrition. To allow the patient up and about, even to go to the toilet, uses up the available oxygen in the muscles before it reaches the feet. It is similar to opening wide, large water outlets in the basement of a house with poor pipes when one is trying to get a supply on the top floor. For this reason a patient with an unhealed ulceration, a local

infection or imminent gangrene must be kept constantly in bed. I believe that even Buerger's exercises, when they have to be undertaken by the patient's own muscular energy, do more harm than good. When they can be done without any effort on the part of the patient, as in the case of the Sanders' oscillating bed, I believe they are physiologically sound and of value.

It is amazing what can be done with cases of demarcated gangrene of the feet and indolent ulcers by these two simple physiologically sound measures, complete bed rest and controlled temperature at 92°F. It takes weeks and perhaps months, but healing which seemed impossible can often be accomplished. The indications for major amputation are still sometimes a matter of dispute among our own staff. Of course, immediate amputation is necessary as a life saving procedure if a patient with advanced arterial occlusion, with or without diabetes, has rapidly spreading gangrene associated with acute infection, fever and leukocytosis. If the process will localize, I am very much on the conservative side of the question. It is important that one man experienced in this work follow the case and do all surgery and dressings himself. In cases of well limited gangrene, operations are dangerous proximal to the productive inflammatory area of the demarcation zone. This zone, like granulation tissue, is more resistant to infections than freshly incised tissues. It is safer not to perform any local amputations until the separation of the living and dead tissue is almost complete which may take many weeks. The gangrenous tissues can then be eased off through the demarcation zone without undue difficulty. No other surgery is performed except simple incisions for drainage. Sloughs should be allowed to separate spontaneously. When a clean granulating base is obtained, small full-thickness skin grafts will often "take."

In trying to encourage epithelium to grow over indolent ulcers, no antiseptics whatsoever should be employed and the parts should be kept clean with normal saline solution. The delicate, growing epithelial edge from the sides of a sluggish ulcer acts very much like a tissue culture which is discouraged by even mild antiseptics, such as peroxide. Gauze is much too rough and shifting to be used as a dressing. Adhesive tape sterilized by passing it over an alcohol flame works well. It does not stick to the wound and forms a smooth, immobile surface under which the epithelium grows readily. This dressing is satisfactory even if there is some purulent discharge, provided the dressing is changed daily. Scrupulous care as to the cleanliness of the skin and nails and avoidance of the slightest trauma are essential. Whirlpool baths are excellent. Warm bed jackets and long wool-lined bed boots are helpful. The head of the bed should be elevated so the foot is a few inches below the level of the heart.

The most favorable patients for this type of therapy are the younger people with thrombo-angiitis obliterans. Only two cases of this disease have come to major amputation. It is also well worth while working with the diabetic and arteriosclerotic groups. Feet with advanced gangrene and infection which seem hopeless sometimes turn out quite well after many weeks or even months of patient care. One often hears the argument that if the circulation is so badly damaged that gangrene has resulted, it is foolish to expect healing, and the foot would be useless if one obtained it. I have many cases to refute this argument and many are reported in the literature.[16] The most discouraging group are the diabetic patients. It is saddening to work several months to get a gangrenous foot well for one of these patients and have him return in a few weeks with another process. However, it is just as apt to be on the other foot; and if one has performed a major amputation already, it is doubly upsetting to have the other side start. This is such a common occurrence that I believe major amputation should not be performed until one is convinced that it is a life saving procedure.

If amputation is to be performed, very careful studies should be made to select the site. It is not at all necessary to amputate in all diabetic and arteriosclerotic gangrene patients above the knee, as has been frequently taught. Personally, I have used the oscillometric readings and the skin temperatures to select the level and have found them to be very satisfactory. Every effort should be made to save the knee joint as it greatly simplifies the patient's problem with the prosthesis. A stump containing six inches of tibia and a good knee joint is ideal and allows the use of as simple a prosthesis as any amputation at a lower level. I have not used the Gritti-Stokes, Callendar or any amputation designed for weight-bearing on the end of the stump, as we believe the most successful type of prosthesis does not use end weight-bearing. The pressure is distributed over the whole area of the stump and skin necrosis is avoided. If one does not wish to risk performing an amputation in the leg, a midthigh amputation is the next choice. A midthigh prosthesis is about as satisfactory as one in the lower thigh or through the knee. We have no amputations above the midthigh, although I have seen cases in which the operator in forcibly retracting the muscles did not realize that he was amputating the femur above its center.

OPERATIVE TECHNIC

The technic of the operation is extremely important. We are dealing with tissues with damaged circulation in which there is almost surely infection in the lymphatics, and the greatest care must be taken to avoid trauma. Even slight insult to tissues predisposes to infection and necrosis. Forceps and towel clips should not be used on the skin. The scalpels should be extremely sharp and incisions bold. Hacking of the fat and muscles with repeated small strokes of the scalpel leaves devitalized bits of tissue which invite trouble. Hemostats should be placed on the vessel alone and not include large pieces of other tissue.

I am convinced the best operation is a modified guillotine. I am opposed to any incision which makes skin flaps. When skin flaps are used, the first sign of trouble is often necrosis of the edge of the longer flap. A circular incision obviates this condition. This brings the scar over the end of the stump, but this does not interfere with the present type of prosthesis. The skin incision, which is carried right down through the deep fascia with one bold stroke of a sharp scalpel, encircles the leg about three inches below the level selected for the bone division. No skin or subcutaneous tissue is raised from its deep fascial connection. In this way, the nutrient arteries to the skin which lie in the deep membranous layer of the superficial fascia are not disturbed and the maximal arterial supply to the skin edges is maintained. The skin, fat and deep fascia retract upward almost without dissection and the muscles are divided about two inches higher, and the same care should be taken to use a very sharp scalpel to avoid any hacking of the tissues. An amputation knife does this stage of the operation best. No tourniquet is employed except hand compression by the second assistant. This avoids any arterial damage by a tourniquet, and it is important to know just how much arterial bleeding there is. An experienced operator can identify and grasp the main vessels as soon as they are divided. The muscles are retracted, the periosteum peeled back and the bone divided about one inch higher than the muscles. If the amputation is through the tibia, it is extremely important to bevel the anterior edge very acutely so the sharp subcutaneous corner cannot cause subsequent pressure on the skin flap. The fibula is divided slightly higher than the tibia. It is not necessary to inject the nerves with alcohol or to cauterize them. Each large nerve should be identified, stripped back and divided high above the level of the incision. This insures against sensitive nerve endings being caught in the scar. With this simple method I have had no painful stumps or neuromas. It is of

paramount importance that not a single suture be placed in the muscles or fascia. None is necessary. Sutures put pressure on the circulation which is aggravated later by postoperative edema, and they tend to close the fascial layers which should be left wide open for drainage. Fascial and muscle sutures are particularly contraindicated in amputations performed in the presence of severe foot infections. The skin is closed by very few skin clips or stainless steel wire sutures one to two inches apart. If the skin is as loose as it should be, the edges should fall together almost naturally and only three or four sutures are necessary. This allows very free drainage without the use of any irritating foreign body such as rubber tubing, etc. The circular incision will leave a corner on each end which can be trimmed down if it is too redundant, but it is better not to worry about it. Experience shows that later on the skin tends to conform very naturally to the shape of the stump and the cosmetic result is quite satisfactory. This operation provides almost as free drainage as a true guillotine amputation, which is undoubtedly the safest operation in the presence of severe infection, and at the same time it avoids the difficulties associated with exposed bone and muscle. The whole operation does not take over twenty minutes, and there seems to be a minimum of shock and postoperative pain. Most of them drain a considerable amount of bloody serum for a few days, promptly heal and result in a satisfactory stump.

Table 1 gives a synopsis of all the patients with gangrene resulting from arterial occlusion, admitted to the surgical wards of Roosevelt Hospital during the last six years.

This series is much too small to be of any statistical value, but I wish to call special attention to the high percentage of toe and leg amputations as compared with the midthigh. The diabetic patients have the highest hospital mortality. The mortality rate of the whole group is about 15 per cent. Most of the deaths were in senile, debilitated patients with advanced disease. Since Welfare Hospital was opened in August, 1939, we have performed ten major amputations on the Second Surgical Division for arteriosclerotic and diabetic gangrene, employing this technic without a single death.

The distribution of cases of arterial disease in the Out-Patient Department without open lesions is shown in Table 11.

TABLE I
SYNOPSIS OF CASES ADMITTED TO THE HOSPITAL WITH FRANK GANGRENE
Total Number of Cases 61

	No. of Cases	Thigh Amputations	Leg Amputations	Toes and Parts of Toes	Hospital Mortality
Arteriosclerotic	24	5	6	13	2
Diabetic	22	3	6	13	4
Thrombo-angiitis obliterans	12	0	2	10	0
Embolic	3	1	1	1	1

TABLE II
CASES TREATED IN THE OUT-PATIENT CLINIC FOR PERIPHERAL VASCULAR OCCLUSION WITHOUT OPEN LESIONS
Total Number of Cases 198

	No. of Cases	Approximate Percentage of Total
Arteriosclerotic	120	60
Thrombo-angiitis obliterans	24	12
Diabetic arteriosclerotic	42	21
Spastic conditions (Raynaud's, etc.)	6	3
Embolic	4	2
Others	2	1

SUMMARY

1. The value of a special clinic for the study and treatment of peripheral arterial occlusion is emphasized. It makes for early recognition, accurate diagnosis and successful management.

2. The physiology of the control of the arterial circulation is outlined. In cases of advanced arterial occlusion, the metabolite

control puts in abeyance any arterial spasm and makes surgery of the sympathetic nervous system valueless. Cases showing improvement of the circulation after nerve block are favorable cases for nonsurgical treatment.

3. A plea is made for conservative treatment of demarcated gangrene when amputation is not necessary as a life saving procedure.

4. The regulation of the temperature in the bed cradle to 92°F. by a thermostat is one of the most important features in conservative treatment. The other is complete bed rest.

5. A modified guillotine amputation without sutures in the muscle or fascia, is recommended as the safest operative procedure.

6. The statistics of the amputation cases are given, showing a preponderance of toe and leg amputations, even in cases of arteriosclerotic and diabetic gangrene.

7. The distribution of cases treated in the Out-Patient Clinic is given, the frequency being in the following order: Arteriosclerosis, diabetic type, thromboangiitis obliterans, spastic arterial disease, embolism and others.

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UTERINE PROLAPSE

AN X-RAY STUDY

FREDERICK L. SCHWARTZ, M.D., F.A.C.S.
Surgical Staff of Mercy Hospital
SAN DIEGO, CALIFORNIA

PROPER evaluation of relaxation of the supporting ligaments and descent of the uterus often presents a difficult problem. Particularly so in the milder cases in which the patient complains of sense of weight in the pelvis, backache, discharge and pain on standing and the only objective findings may be increased mobility, congestion of the uterus and varicosities in the broad ligaments.

The human equation enters into the decision as to whether or not a moderate degree of descent is responsible for the symptoms manifested, and our best test is the symptomatic response to support. In the advanced degrees of prolapse the condition is obvious and the only problem is that of treatment.

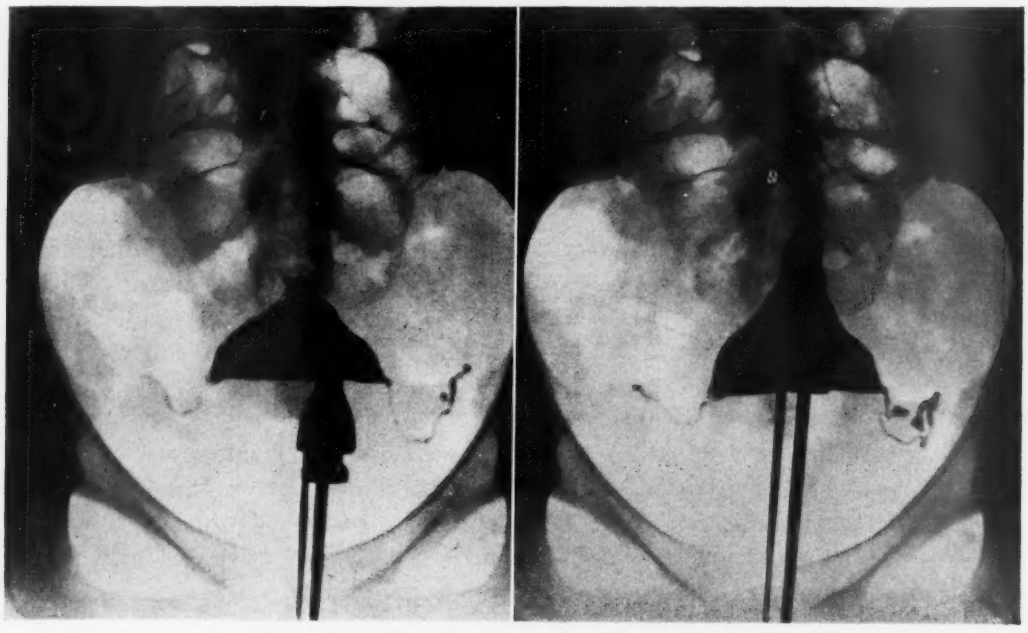
The frequent industrial and automobile injuries often create situations in which it is most difficult for the gynecologist to give a definite answer. A typical case is one in which following an injury a patient who has previously been well complains of backache, discomfort on standing and the usual attending symptoms. There may, or may not have been bony injury. Examination shows the uterus in good position with some relaxation of the supporting ligaments. The patient states that rest and support relieve her symptoms, but such a statement, like the symptoms complained of, may be colored by the desire for compensation. It is in such a case, that capable gynecologists may differ in their opinions as to the existence of sufficient damage to account for the symptoms. A recent case in court, with several capable experts expressing opposite opinions, convinced the writer for the need of some more objective method of evaluating such a condition. A search of the literature revealed little of assistance, therefore, this study was begun in the hope of being able to express in definite figures the normal ascent and descent of the uterus, and to create some sort of yardstick with which abnormal mobility might be measured.

In hysterosalpingography advantage of uterine mobility is often taken to bring into view tubes that are otherwise obscured by the uterine shadow. This gave rise to the thought that with minor changes in technic, the uterine excursion might be directly measured on the *x*-ray film. The relative position of the fundus, anterior or posterior, was not considered of importance. It is true that acquired retroversions cause symptoms, but then there are usually additional findings together with congestive changes in the pelvic organs. In the normal pelvis the point of attachment of the cardinal ligaments represents the most firmly fixed point of the uterus. Measurement of longitudinal mobility at this point would accurately measure the mobility of the entire organ. This, however, offers difficulties, but the tip of the intracervical cannula lies just below and in constant relation and provides a satisfactory substitute. With the cervix firmly held in the same position relative to the long axis of the body, measurement of the cephalad and caudad excursion of the cannula within the cervix provides a satisfactory and convenient method of determining such mobility. Measurements from the upper border of the symphysis pubis to the tip of the cannula give the relative position and the exact amount of mobility.

TECHNIC

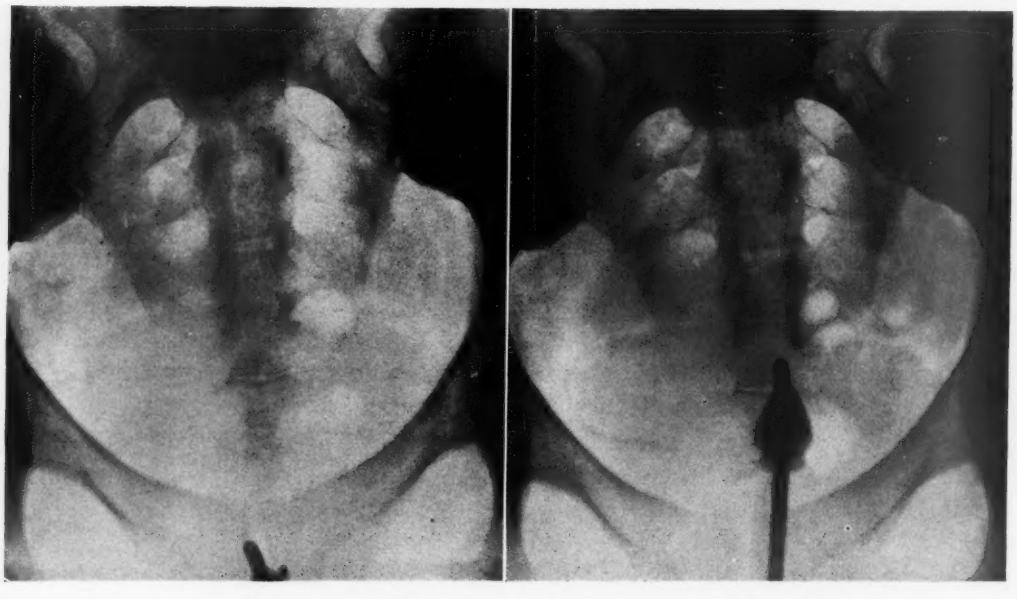
The patient is positioned on the table as for a gynecologic examination, and a tube

distance of thirty inches is used. In exposing the cervix a speculum with a divided anterior blade is desirable so that it may



A B

FIG. 1. A and B. Case 7. Normal anteverted uterus. Low and high positions.



A B

FIG. 2. A and B. Case 3. Second degree prolapse with marked symptoms preoperatively. No contrast material used.

later be slipped out of the vagina without disturbing the cervical tenaculum or the cannula. After the desired number of films using varying amounts of contrast media have been exposed, the speculum is removed from the vagina. With the speculum in place there is a certain amount of splinting of the vaginal walls and limitation of motion. Taking care to keep in the long axis of the body, the uterus is pulled as far downward as possible and a film exposed. Next, the procedure is reversed and a film is made with the uterus at the cephalad limit of its excursion. In this maneuver pressure is made on the uterine cannula

and the cervix is steadied by the tenaculum. Measurements taken from these two films give the upper and lower limits of motion. In this work the Hyams cannula has been found most convenient and has been used routinely.

space, and traction only serves to fix it more firmly in the cervix.

For the purpose of obtaining standards from which conclusions might be drawn twenty-five cases were studied. All but three were consecutive cases in which

TABLE I

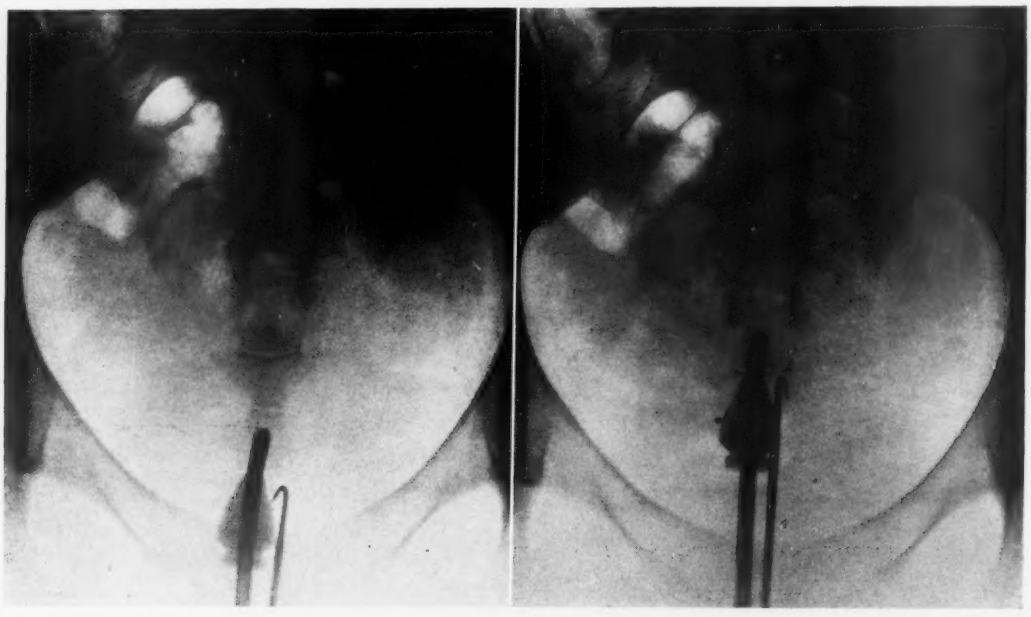
Case No.	Age	Weight	Gravida	Para	Diagnosis	Pressure Symptoms	Low in Cm. above Pubis	High in Cm. above Pubis	Long. Mobility in Cm.	Comments
1	32	108	4	3	Fibroids	0	6	8	2	Bleeding main symptom
2	69	122	12	10	Prolapse	3+	−5	3.5	8.5	Fair comfort with pessary
3	29	167	3	3	Prolapse 2°, preoperative	3+	−1.5	5	6.5	Unable to carry on with household duties
4	29	167	3	3	Same case, postoperative	0	3.5	7	3.5	Postoperative—well
5	25	110	0	0	Ov. cyst, salpingitis, sterility	1+	2	6.5	4.5	Previous tubal masses, large cyst on right
6	33	140	4	0	Fibroids, sterility	0	6	8.5	2.5	Intraligamentous fibroid
7	19	96	0	0	Sterility	0	7.2	10.	2.8	No symptoms
8	27	101	0	0	Sterility; gen. ptosis (injury)	1.+	3.5	8	4.5	Symptoms after several months in cast
9	26	106	2	2	Fibroids, chr. salpingitis	1+	1.5	6.7	5.2	Relief with pessary
10	30	170	6	2	Fibroids	1.+	.6	4.8	4.2	Constant complaints; neurosis
11	48	165	0	0	Fibroids	0	6	9.5	3.5	Bleeding, D and C and radium
12	44	133	1	1	Fibroids	0	3.5	6	2.5	Bleeding only symptom
13	24	120	1	1	Sterility, salpingitis	1.+	3	7.2	4.2	Relieved by treatment
14	33	91	1	1	Sterility, salpingitis	1.+	1.5	5.5	4.	Repair since; relieved
15	33	125	0	0	Sterility, salpingitis	0	5	6.8	1.8	Old salpingitis
16	42	155	0	0	Sterility, postoperative	0	5.3	8.	2.7	No symptoms
17	35	171	0	0	Sterility, salpingitis	0	8.5	10.5	2.	No symptoms
18	35	134	2	1	Sterility, salpingitis	0	6.6	8.7	2.1	No symptoms
19	25	115	1	1	Sterility, salpingitis	2+	3.3	7.1	3.8	Recurrent pelvic cellulitis at time of examination
20	26	108	0	0	Sterility, salpingitis	1+	3.	8.5	5.5	Previous large tubal masses, now pregnant
21	24	115	0	0	Sterility, salpingitis	0	4.	7.	3.	Hystero. account sterility
22	28	190	0	0	Sterility, salpingitis	0	5.8	7.3	1.5	Hystero. account sterility
23	27	110	0	0	Sterility	0	3.5	7.	3.5	No other symptoms
24	25	190	1	1	Sterility, salpingitis	0	6.5	9.5	3.	Mild salpingitis and sterility since labor
25	24	108	0	0	Sterility, salpingitis	1.+	1	5.5	4	Appendicitis; pelvic peritonitis five yrs. before

The usual cervical tenaculum was found to be unsatisfactory in several ways. When traction is exerted, the instrument usually tears out. If a more adequate bite is taken, the direction of the cervix is changed and the canal may be partially blocked. To obviate these difficulties a new instrument which has recently been described was devised.[1] This tenaculum requires less

hysterosalpingography was done for some indication. In the three selected cases films were made in the same manner but without the injection of the contrast material. When the amount of relaxation is the only question, the shadows of the instruments without the outline of the uterus are adequate for measurement and this procedure saves both time and expense.

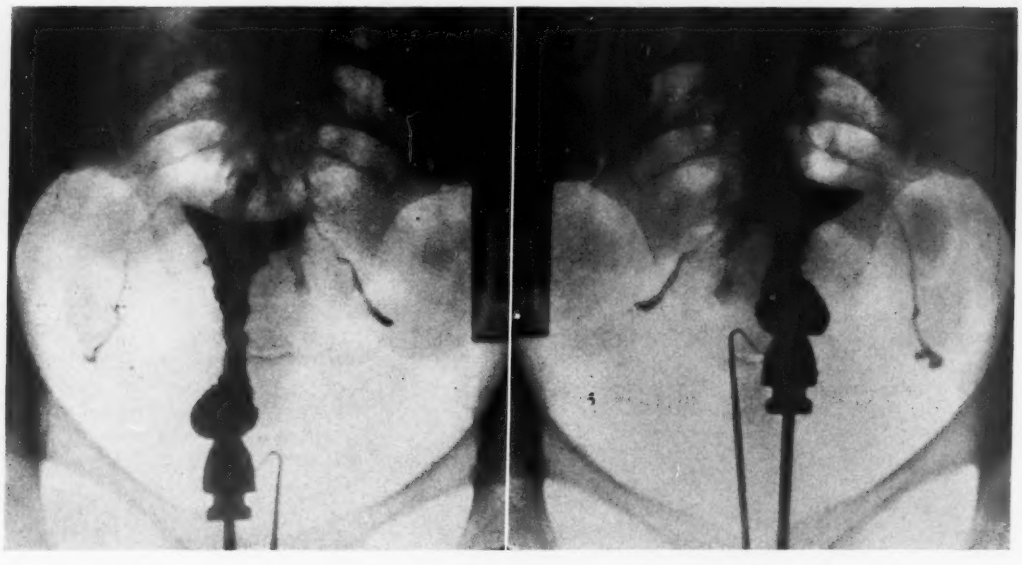
In considering the data obtained, it must be noted that the figures given are only relatively accurate. There is a slight magnification in the *x*-ray film and there is another variant depending on the depth of the pelvis. However, these are not significant and if all films are made under standard conditions, the measurements taken directly from the films are satisfactory for drawing conclusions.

The findings together with a few pertinent facts regarding each case is given in Table 1. Most of the columns are self-explanatory. As previously stated, these were all private patients seeking diagnosis and relief of symptoms. None of these patients was involved in litigation or had any object in misstating symptoms or their relief. Pressure symptoms were not accepted as being present unless relief was



A B

FIG. 3. A and B. Case 4. Same patient postoperatively. No symptoms.



A B

FIG. 4. A and B. Case 11. Normal mobility. Submucous fibroids and cavity in cervix considered possible early endocervical carcinoma; negative on biopsy. Hyams cannula and author's tenaculum.

obtained by support. For convenience, pressure symptoms were arbitrarily graded as from one to three plus. One plus were patients with mild symptoms who obtained complete relief with occasional treatment. Two plus were those with more definite symptoms and who exhibited some discomfort in spite of more or less continuous treatment and of sufficient intensity to consider surgical relief. Those graded as three plus had symptoms severe enough to limit their activities definitely and surgery was necessary.

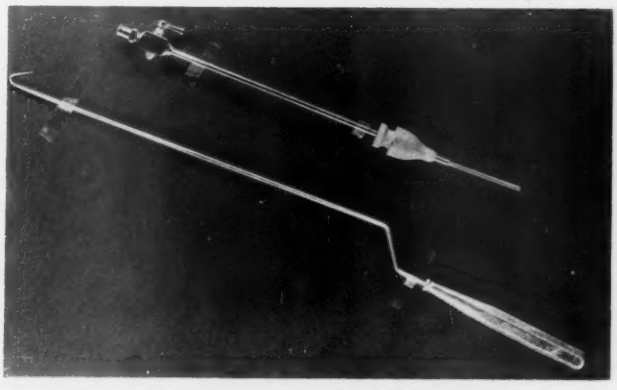
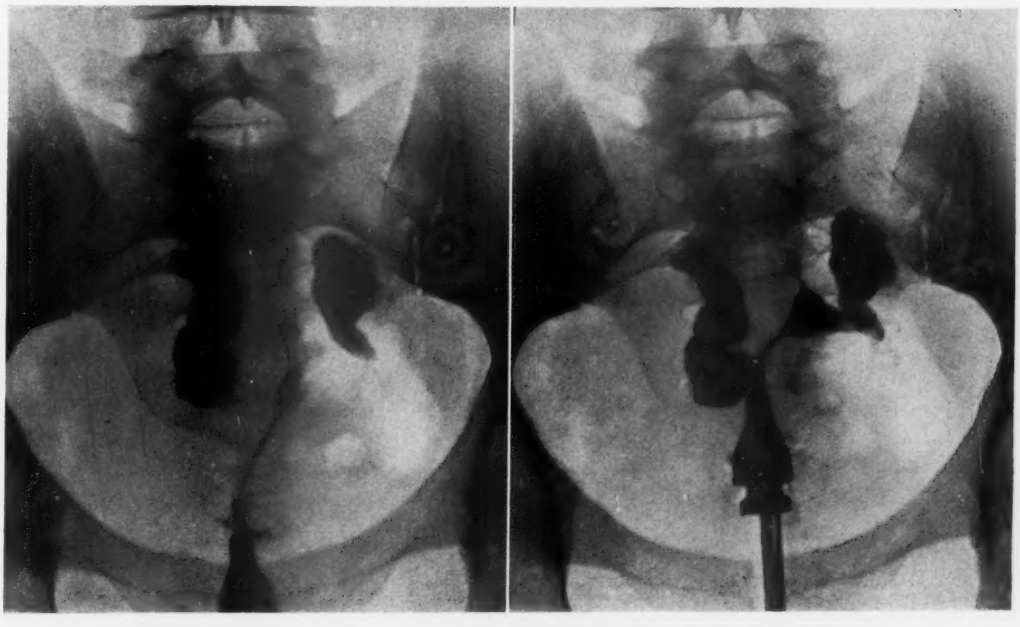


Fig. 5. Hyams cannula and author's tenaculum.



A B

Fig. 6. A and B. Case 5. Abnormal mobility. Bilateral hydrosalpinges and large right ovarian cyst. Films made with viscous skiodan. Uterine shadow in 6A lost due to absorption.

In eleven cases that manifested pressure symptoms, the uterine motion varied from 3.8 to 8.5 cm. In Case 19 with 3.8 cm. motion there was a rather acute pelvic infection associated with the relaxation. The position of maximum descent relative to the symphysis in this group varied from −5 to plus 3.3 cm. The smallest deviation from the normal was manifested by the patient with associated pelvic inflammation. It might be added, that this patient failed to mention the recurrence of her pelvic infection until after the examination was made. Among the women in this group seven or 63 per cent had borne children. Two of the other four, Cases 5 and 20, had had large tubal masses, and Case 5 still

presents a large right ovarian cyst. No doubt pressure was a factor here in causing uterine descent. Case 8 presented generalized muscle weakness, and this followed a back injury and prolonged treatment in a cast. Case 25 developed symptoms after a ruptured appendix and pelvic peritonitis five years before.

In the group without pressure symptoms four out of fourteen had borne children. The low point above the symphysis varied from 3.8 to 8.5 cm. Motion varied from 1.8 to 3.5 cm. Another interesting finding was that in heavy women with increased anteroposterior diameter of the pelvis, the uterus tends to be higher. However, this may be mainly apparent due to the increased angle at the pubis. Cases 3 and 4 are interesting in that they are studies of the same patient before and after an extensive repair operation.

CONCLUSION

1. Uterine position and mobility may be accurately measured by the technic described.

2. A low point less than 3.5 cm. together with mobility greater than 4 cm. indicates uterine relaxation of sufficient degree to be capable of causing symptoms

SUMMARY

A method for measuring longitudinal motion of the uterus is presented and the results in twenty-five cases are tabulated. It is admitted that the number is small but the findings have been consistent. Cases studied while developing the technic now used and also cases studied after this series was completed are in accord with these findings. The average mobility in the group without symptoms was 2.6 cm. and the average low above the symphysis was 5.5 cm. In the group with symptoms the average mobility was 5 cm. and the low point above the symphysis 1.2 cm.

In cases presenting borderline measurements some allowance must be made for the varying thresholds of discomfort in different women. Additional studies may result in some slight modification of the figures given, but it is believed that the given method will provide a simple and accurate objective method of determining the existence and extent of abnormal uterine relaxation.

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TOTAL HYSTERECTOMY

JOHN ROBERTS PHILLIPS, M.D.
Visiting Surgeon, St. Joseph's Infirmary

AND

ERNEST SEARS, M.D.
Visiting Surgeon, St. Joseph's Infirmary

HOUSTON, TEXAS

THE advance of surgical pelvic technic in abdominal hysterectomies has changed the ratio of subtotal to total operations considerably in recent years. In former times subtotal hysterectomy was generally chosen for all benign conditions necessitating an operation, and the total form of surgical treatment was applied exclusively in malignant cases. Complete hysterectomy is performed also for benign disturbances of the uterus, and is gaining lately more and more ground in the treatment of benign conditions of the uterus. The pioneer work was done in large institutions as University, State and County hospitals, where diagnosis indicating operation was under direction of a closed staff utilizing strict principles. In the larger private institutions, where a great number of surgeons do their work according to their own ideas and principles, differentiating substantially from each other, the switch toward total hysterectomy has not reached the right acceptance which it should have.

Nelson and Weisberg in a collected series of cases from the literature combined with their own series summing up 14,591 hysterectomies in all, have reported the ratio of total to subtotal operations as approximately 1:2. This ratio is to be considered recommendable. But in private hospitals the ratio is till 1:4, 1:5 and even 1:6. A ratio in which total hysterectomy is performed more frequently than subtotal, with excellent end results, is reported by Harris and by Masson. The attitude toward total hysterectomy amongst various authors varies still to a great extent as can be seen in Table 1 collected from the recent literature.

The difference in the mortality rate between one form and the other is almost negligible, as evident from this table and other reports, but only as long as the operation is performed by an expert hand. The untrained and unexperienced will, of course, have a considerably higher mortality in total hysterectomies. Nelson and Weisberg observed that the greater the number of total hysterectomies done in any one series, the lower the mortality. In other words skill is the most important factor in the performance of total hysterectomy.

TABLE 1
ABDOMINAL HYSTERECTOMIES

Authors	Abdominal Hysterectomies	Subtotal	Mortality, Per Cent	Total	Mortality, Per Cent
Nelson and Weisberg	14,591	9,606	3	4,985	3.56
Tyrone	453	316	1.9	137	2.2
Harris	1,145	314	0.6	831	0.6
Masson	2,542	766	0.9	1,776	1.2
Phillips and Sears	173	141	1.41	32	0

TABLE II

	Number and Per Cent	Average Age in Years	Morbidity (Days in Hospital)	Mortality, Per Cent
Subtotal	141 (73.82)	38.0	13.1	1.41
Total	32 (16.75)	41.7	12.5	0
Vaginal	18 (9.43)	56.6	13.2	0
Summary	191	40.6	13.1	1.05

In our own series of 191 consecutive hysterectomies performed by different surgeons of the active and courtesy staff at St. Joseph's Infirmary, Houston, we had as Table II shows, 141 subtotal (73.82 per cent), thirty-two total (16.75 per cent) and eighteen vaginal (9.43 per cent) hysterectomies. Without any doubt, the number of total hysterectomies is far below the desirable percentage. But St. Joseph's Infirmary is a foremost private institution, where the indication of one type of opera-

tion or the other is determined individually by every surgeon without commonly outlined principles and with a widely varying background as far as training is concerned.

The average age for all hysterectomies was 40.6 years, for subtotal 38.0, for total 41.7 and for vaginal 56.6 years. The stay in the hospital until discharge was on an average of 13.1 days. There was no marked difference of morbidity between one form and the other; the morbidity in total hysterectomies was even slightly lower. However, it must be mentioned that such an estimation of morbidity is incorrect, as the difference of the financial status of different patients changes not inconsiderably the surgeon's advice, at least as to the minimum stay in the hospital. Out of 191 operations we had two deaths (1.05 per cent), both after subtotal hysterectomy which brought the mortality of the latter up to 1.41 per cent. The thirty-two total and eighteen vaginal hysterectomies were without fatality.

The attitude toward total and subtotal hysterectomy is still in many points controversial. Many physicians are hesitating to perform a complete hysterectomy because of higher risk, increased shock, higher mortality and higher morbidity, as they claim. But statistics of competent surgeons eliminate these fears, because they show clearly that the morbidity in total hysterectomies is not increased, often decreased, and that the end results are by far better.

If the only purpose of total hysterectomy would be to avoid the possibility of later developing cancer in the stump, as advocated by Jones, the utilization of this operation would be greatly limited, because the incidence of cancer in the stump after subtotal hysterectomy in benign cases is only about 1 to 2 per cent. But we all see patients coming back after subtotal hysterectomy stating the operation gave them only temporary or partial improvement. They complain of arthritic and myositic disturbances, and upon examination we find a well developed cervicitis with leukorrhea, which eventually makes a later surgical intervention necessary. Many of these patients change their doctor because they think the first operation was not successful, therefore making it an impossibility to follow up the postoperative results. If a perfect follow-up after subtotal hysterectomy were possible, we are inclined to believe that the incidence of unsatisfactory end results would be much greater.

Often surgeons will not perform a total hysterectomy, because they believe in opening the vagina the danger of infection is increased. We agree with Masson, who states that by applying a meticulous technic including surgical preparation of the vagina the danger of infection is less, because "in subtotal hysterectomy the cervical glands are cut across and often transversed by sutures," thus forming a focus of infection if the cervix was previously inflamed. Also cauterization and conization of the cervix cannot prevent infection as "those procedures leave a sloughing region continuous with the operative field and peritoneum." Tyrone's opinion in regard to this is as follows: "We are now performing the complete operation more often, not only because of the danger of malignancy in the remaining stump, but because a diseased cervix produces definite and annoying symptoms, whether the uterus is in or out of the patient." We, ourselves, might add that we do not know what purpose a cervix serves without the body, especially in women near or at menopause. Richardson reported that in follow-up examinations of women who have borne one child or more, unsatisfactory conditions of the cervix or the lower birth canal were found in 50 to 75 per cent. Why then preserve a cervix, unless for some important reason?

The objection that following total hysterectomy, sortening of the vagina, diminished secretion of the vaginal mucosa, and prolapse of the vaginal vault—all causes of dyspareunia—do not infrequently occur, is not tenable if the proper technic is employed. Experienced operators, who

did total hysterectomies on a large scale deny these occurrences so well as injuries to ureters, bladder and bowels; the latter occur in unexperienced hands, also in subtotal operations. Furthermore, if the surgeon possesses the necessary skill, the slightly greater technical difficulty of the total operation should be no hindrance to the performer. Only in very obese women and in patients who have an unusually deep pelvis do we encounter some difficulties.

Also the time factor is not a sufficient argument to reject complete hysterectomy, because the duration of the operation is usually estimated to be prolonged from three to ten minutes (three more minutes according to Nelson and Weisberg; five to seven more minutes, according to Tyrone).

Therefore, we would advise total hysterectomy in the following cases: (1) In women who had one or more children by vaginal delivery, requiring hysterectomy for conditions of the corpus uteri; (2) in women near or at the menopause with uterine pathology requiring hysterectomy; (3) in all cases necessitating operation for conditions of the uterine body, in which the cervix is also diseased: (a) lacerations, (b) inflammation (cervicitis), (c) benign cervical tumors (polyps, cysts, etc.); (4) in all malignant cases.

For the advisability of subtotal hysterectomy we like to quote Richardson who considers the following cases as suitable for this operation: (1) Women requiring hysterectomy for benign conditions, who possess perfectly normal cervices (mostly young women and nullipara); (2) instances in which the operative hazard compels the execution of conservative surgery; (3) cases in which for good and sufficient reasons it is of paramount importance to preserve menstrual function; (4) most cases requiring hysterectomy during pregnancy.

A word might be said about the adverses. Usually in performing a total hysterectomy we also remove both tubes. In that way the toilet and peritonization are greatly facilitated. There is less likelihood of pelvic inflammation; the blood supply to the ovary is improved since there is not the increased strain of nourishing the tube. However, we try by all means to preserve one or at least a part of the ovary corresponding to the pathological involvement of the ovaries whether the woman has passed menopause or not, as long as complete atrophy of the ovaries has not taken place. Caution should be observed not to fix the ovary to the vaginal vault because this often causes dyspareunia, but instead to bury it between the folds of the broad ligament.

We usually make use of Masson's technic for complete hysterectomy, and this with good results. Here we can only briefly emphasize the most important steps of the operation. The operation is performed in the same way as for subtotal hysterectomy, only that in addition the bladder is freed way down from the cervix and the vaginal vault. The cervix should be enucleated from the vaginal vault. As soon as the vagina is opened and the cervix enucleated, we insert an iodine sponge which is removed after the operation. The vaginal vault is closed with a continuous mattress suture in two rows rolling the cut edges of the mucosa into the vaginal canal. Then the peritoneum and the uterosacral ligaments are brought upward and placed over the vaginal vault. After that the round ligaments are approximated and overlapped and secured to the vaginal vault, to the tissues in the base of the broad ligament, to the stumps of the uterine vessels and to the uterosacral ligaments. Peritonization of the raw surfaces completes the operation. No drains are used. Employing this technic, an injury to the ureters, bladder and bowels as well as shortening of the vagina can be relatively easily avoided.

Concluding, we believe that with proper technic the risk of total hysterectomy is not much greater than in subtotal hysterectomy. The satisfactory end results should make this operation much more popular than it actually is at the present time.

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Constant rales at the lung bases are never found in the normal pregnant woman. When they appear in a Group 1 cardiac, they constitute the most reliable and earliest sign of heart failure.

From—"The Heart in Pregnancy and the Childbearing Age"—by Burton E. Hamilton and K. Jefferson Thomson (Little, Brown and Co.).

PRURITUS ANI

ALFRED J. CANTOR, M.D.
Assistant Attending in Gastroenterology, Queens General Hospital
FLUSHING, NEW YORK

THE tattoo treatment for pruritus ani has recently come into prominence. It offers definite promise as a distinct advance in the treatment of this often baffling syndrome. Pruritus ani may be very pernicious, and we have all seen cases in which conservative methods of therapy have yielded only very transient benefits. The multiplicity of suggested treatments bears adequate witness to the fact that no therapy is very successful. Ointments, anesthetic powders, injection of water-soluble or oil-soluble anesthetics, alcohol injections and electric treatments have all been suggested and employed with varying degrees of success.

When conservative measures have failed, and when no rectal or anal pathology other than the postpruritic skin changes are present, tattoo therapy is indicated. If hemorrhoids, internal or external, fissure, fistula, proctitis or other pathology is present, these conditions must first be brought under control. If the pruritis still persists, we may proceed with tattooing. Obviously, sigmoidoscopy must be negative and the urine free from sugar.

Because of the uniformly poor results that I have observed as a consequence of haphazard, unskilled tattoo technic, this paper will limit itself to a discussion of proper tattoo technic.

The instrument employed has a speed of about 3,000 vibrations per minute. The needle bar holds eight to ten needles. This number is arbitrarily chosen because it offers a broad, easily handled working tattoo surface.

A lesser or a greater number of needles might be employed. The needles are very fine, are set in a single row and are adjusted to penetrate to a 2 mm. depth. To eliminate vibration, and to permit better instrument control, the operator may maintain his elbow close to his body. The instrument shaft is held between the thumb, index and middle fingers, curving the ring and little fingers outward upon the patient's skin. This position of the latter two fingers serves to further steady the instrument and to aid in guiding its direction and motion.

The needles must form an oblique angle of about 45 degrees with the skin. They will then penetrate the skin obliquely and will deposit the dye particles at the proper depth. The motion of the instrument may be back and forth, or rotary in small circle areas. The dye penetrates, however, only with the stroke toward the direction of the needle points. The machine may be lifted off the skin in a series of brushing strokes, starting from various points on the circumference of the perianal area and proceeding radially inward toward the anus, maintaining the 45 degree angle, and moving toward the needle points with each stroke. This requires greater effort than the back and forth motion, because of the added lifting of the instrument. I prefer the back and forth motion for broad sweeps, and the small-circle rotary technic for touching up smaller areas.

It is exceedingly important to keep the skin under tension while tattooing. Every perianal fold must be straightened and the entire perianal region must be carefully tattooed. If the skin is not held under tension, the tattoo will be ineffective. Skin tension may be maintained by the operator's left hand or by an assistant.

Cinnabar, (mercuric sulfide) is the dye employed. It is a red powder. A few cc. of sterile distilled water, alcohol, solution of merthiolate or procaine are added to a small quantity of the dye, and a heavy solution is made. Water alone is adequate.

The other solutions are suggested for added antiseptic or anesthetic effect. The needle points are dipped into the dye mixture from time to time while tattooing.

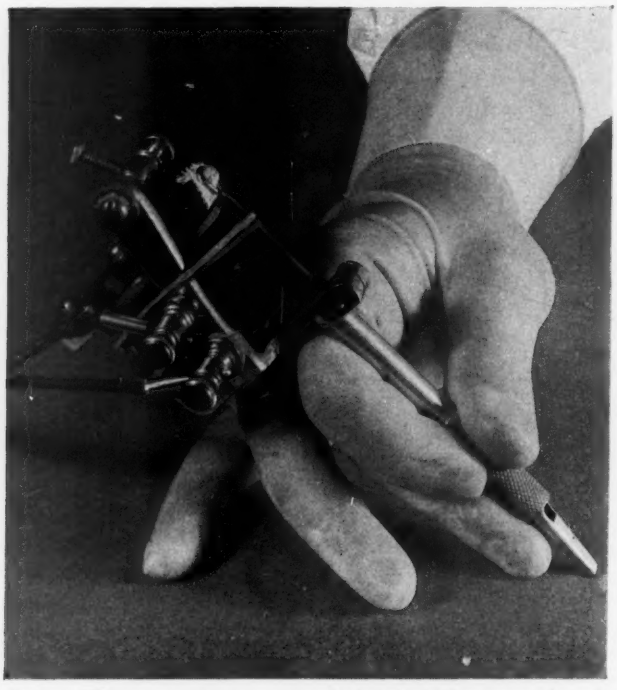

Fig. 1. The tattoo instrument shaft is held between thumb, index and middle fingers, the ring and little fingers being spread-eagled upon the patient. The instrument is held at a forty-five degree angle.

The patient is prepared by shaving the perianal area. Tincture of green soap may be employed for this operation. Antisepsis consists of iodine or tincture of metaphen followed by alcohol. The area of preparation, as well as the section to be tattooed, should extend well beyond the pruritic zone.

Anesthesia may be local infiltration, sacral block, or spinal. My personal belief is that this is an office procedure, and my preference, therefore, is local infiltration anesthesia. Oil-soluble anesthetics have been injected under the skin of the perianal region as a method of therapy for pruritus ani. I would suggest the use of an oil-soluble anesthetic as the pretattoo anesthesia. This would also obviate post-tattoo discomfort. Various formulas have been suggested for oil-soluble anesthetics.

Gabriel's modified solution is oil of sweet almonds containing 0.5 per cent nupercaine, 1.0 per cent phenol and 10.0 per cent benzyl alcohol. Anucaine, containing in each 5 cc., procaine base 0.05 Gm., butesin, (n-butyl-p-amino-benzoate, Abbott) 0.20 Gm., benzyl alcohol 0.25 Gm., and sweet almond oil q.s. 5.00 Gm., is recommended. Morgan's solution is peach-kernel oil containing 1.5 per cent procaine, 6.0 per cent butesin, and 5.0 per cent benzyl alcohol. Still another formula contains eucupin base 0.2 per cent, ethylaminobenzoate 3.0 per cent, benzyl alcohol 5.0 per cent and oil of sweet almond q.s. Eucupin is isoamyl-hydrocupreine, an alkaloid synthesized from quinine.

TECHNIC

Because of the importance of proper infiltration of the oil soluble anesthetics, this technic will be briefly outlined. Any syringe may be employed, but a 10 cc. Luer-Lok type, with a twenty gauge two inch needle is probably most satisfactory. Warm the anesthetic solution before drawing into the syringe. A primary procaine

wheal may be raised at the sites through which the larger oil bearing needle is to be inserted, but this is not essential. The entire perianal area must be injected if a complete tattoo is to be done at one treatment. It may be preferable, in some cases, to inject and tattoo only half the circumference area of the pruritic zone at each of two treatments. Infiltration is subcutaneous, fanwise in distribution, slowly and evenly injected, with careful avoidance of pooling. Injections may be started from anterior, posterior and lateral points, injecting while withdrawing the needle. Twenty to 30 cc. of solution will be used for complete perianal infiltration. Massage of the injected area will aid in preventing pooling.

When anesthesia is complete the skin is coated with an ointment. Nupercainal, carbolated vaseline, or lanolin may be employed for this purpose. The ointment serves the purpose of holding the dye particles on the skin area to be tattooed. Tattooing may then proceed. The cinnabar dye particles are heavier than the usual tattoo pigments and are, therefore, more difficult to drive into the skin. Thus, a certain amount of bleeding will result. This should be frequently and continuously sponged in order not to obscure the field of operation.

The technic described should be carefully followed. Skipped areas will result from improper management of the procedure. Failure to hold the needles at the proper angle will produce ulcerations and sloughs. Gauge the depth of the needles by the feel of the instrument in motion and by the appearance of the tattoo. There should be no sticking or jarring, and the tattoo should be smooth and uniform. Proper evaluation of this method of therapy can be made only by those who have acquired a skillful tattoo technic.

Fig. 2. Tattoo preparation: the instrument and transformer. In front of the transformer are two ampoules of anucaine and a large ampoule of triple distilled water to mix with the dye. A bottle of antiseptic solution and the two syringes are also shown. The smaller syringe is for procaine, the larger for the anucaine.

SUMMARY

Tattoo therapy is indicated in cases of pernicious pruritis ani when more conservative measures have failed and when no rectal or anal pathology other than the post-pruritic skin changes are present.

Anesthesia for this office procedure may be local infiltration, preferably with an oil-soluble anesthetic. Anesthetic formulas and the technic of infiltration anesthesia are described in detail. Twenty to 30 cc. of solution, carefully injected to prevent pooling, is usually adequate.

After anesthesia, the perianal area is coated with an ointment, such as lanolin, nupercainal or carbolated vaseline, to hold the dye particles during tattooing. The dye employed is cinnabar (mercuric sulfide), making a heavy suspension in water, alcohol, solution of merthiolate or procaine. The tattoo instrument has a speed of about 3,000 vibrations per minute and employs eight to ten needles. The needles are dipped into the dye mixture from time to time while tattooing, and are held against the perianal skin at a 45 degree angle. The skin must be kept under tension, while the instrument is used with a back and forth or rotary motion.

The resulting tattoo should be smooth and uniform.

"Essential" hypertension may depend upon atheromatous narrowing of the orifices of the main renal arteries, or by kinking, or by pressure upon these vessels by new growths.
From—"Convalescent Care"—(New York Academy of Medicine).

BENIGN PAPILLOMA OF THE RENAL PELVIS*

FEDOR L. SENGER AND JOHN J. BOTTONE
BROOKLYN, NEW YORK

PRIMARY tumors of the renal pelvis are of rare occurrence. The majority of them are papillomatous, far outnumbering the squamous cell type. While it is usually believed that the true papilloma is the most frequently found, nevertheless series of cases are reported in which the malignant tumors are much more numerous. Hugh Young agrees with this, stating "benign neoplasms of the renal pelvis are exceptionally infrequent, malignant changes being usually found upon close and careful pathological examination." It is this rarity that prompts us to report this case, the only one in the records of the Long Island College Hospital as far as we are able to ascertain by diligent search.

We quote from a paper published by us in the *American Journal of Surgery* in 1937 on primary epithelial tumors of the renal pelvis: "The benign papilloma usually arises in the renal pelvis and metastasizes to the ureter and bladder by direct extension and implantation. These tumors are as a rule multiple and may be extremely numerous, covering the entire mucosa with fine vegetations. Occasionally there is seen one large tumor with several small polyps scattered over the pelvis and calyces. The tumors are villous or wart-like, attached by a narrow pedicle and expand in a fan-like shape. Their greater vascularity is a source of hemorrhage which is the chief symptom. Incrustations with salts and calcui are frequently seen. Various grades of hydronephrosis often result from partial occlusion, chiefly by ureteral transplants. The microscopic structure is typical and consists of elongated blood vessels covered by multiple layers of transitional epithelium. The tumor cells are cubical, cylindrical or elongated and spindle-shaped, but the arrangement is orderly and the growth is confined to the mucous membrane. Round cell infiltration is found at the base of the tumor. The course of these tumors is usually benign but they may become malignant by invasion of the submucous layers, so that they always should be considered potentially malignant. Recurrences after removal or from implantation in the wound, have occurred in a malignant form."

This disease is one of adult life; most cases occur in individuals between the ages of forty and seventy years. Its origin is still a matter of conjecture, yet one cannot lose sight of the prominent part played by chronic irritation and infection over a long period of time. The importance of congenital abnormalities in the production of these growths is problematical.

The symptomatology of pelvic papillomas is that of any renal neoplasm. In their order of frequency of occurrence, and chronologically the symptoms are hematuria, pain and tumor mass. Hematuria occurs in seventy out of ninety cases and is often intermittent and painless, but occasionally may be colicky due to the passage of clots. The pain may be a dull, persistent ache in the renal area or a true colic and may result from ureteral obstruction caused by blood clots or ureteral tumor transplant. The tumor mass is most often a hydronephrotic enlargement of the kidney.

For the diagnosis of renal pelvic neoplasm, one must depend largely upon cystoscopic and pyelographic findings. A picture of a more or less dilated pelvis within which one visualizes a filling defect is fairly characteristic. The presence of a tumor transplant about the ureteral orifice or the adjacent bladder wall asso-

* From the Urological Departments of the Long Island College of Medicine and the Long Island College Hospital.

ciated with these findings points strongly to a neoplasm of the pelvis. However, considering everything the diagnosis is made

Fig. 1. Pyelogram showing characteristic deformity.

with difficulty preoperatively. One must consider in the differential diagnosis defects due to incomplete filling of the pelvis with pyelographic medium and defects due to blood clot. It would also be difficult to exclude a parenchymal tumor that had secondarily invaded the pelvis.

As regards the treatment of tumors of the renal pelvis, whatever the nature of the growth, surgery is indicated. The well known tendency of the papillomatous neoplasm to progress by extension along the mucous membrane of the ureter and into the bladder, along with their high incidence of recurrence in malignant form, makes it imperative that the surgery be of a radical nature. Therefore, complete nephro-ureterectomy including the resection of a portion of the bladder wall immediately adjacent to and surrounding the isolateral ureteral orifice is recommended. Occasionally where indicated, because of the patient's poor condition, it may be advisable to perform the operation in two stages, the nephrectomy first and the ureterectomy later. Simple nephrectomy is justifiable only as a palliative measure. Roentgentherapy offers us very little hope.

CASE REPORT

The following is the report of a sixty-three year old Czechoslovakian machinist who was admitted to the urological service of the Long Island College Hospital on August 16, 1939. He had never had any urinary symptoms prior to the evening before admission when he noted a moderate amount of blood mixed with his urine. That night he voided three more times, very unusual for him, and each time the urine was pink in color. He had no pain whatsoever, although he did have slight soreness in the left flank.

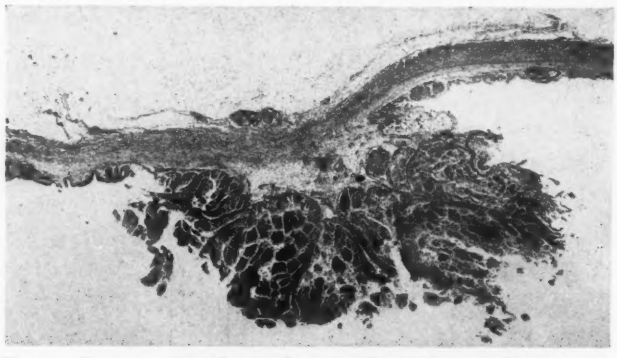

Fig. 2. Low power photomicrograph of the papillomatous growth.

The past history included malaria in 1907 and psoriasis in 1932. Venereal disease was denied by name and symptoms. He had a right hydrocele for years. He admitted drinking at least a quart of whiskey each week for years.

Physical examination revealed the patient to be a stolid, well developed flabby looking, co-operative white male, who looked his stated age. The only positive findings were many carious teeth, a left nontender, palpable kidney which did not feel enlarged and a large right hydrocele of the tunica vaginalis.

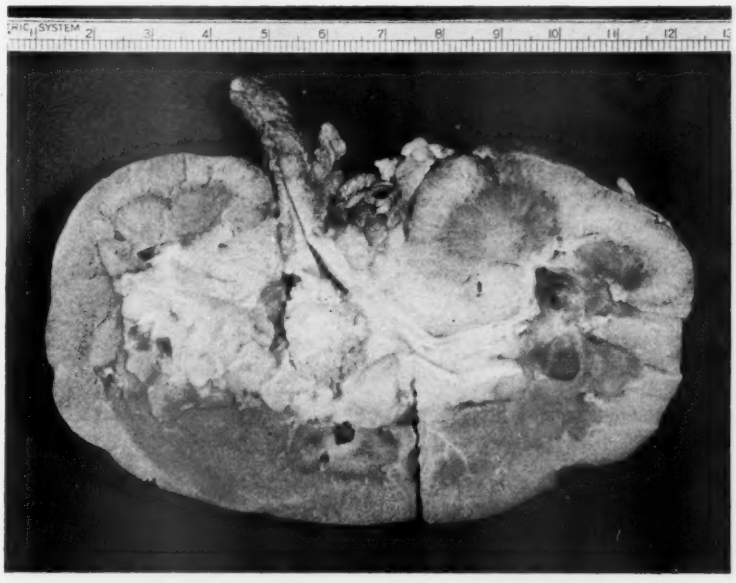

Fig. 3. Gross specimen, illustrating tumor in the kidney pelvis.

The bladder urine was bloody but not all blood. The capacity was 10 ounces. The mucose, trigone and bladder neck were normal. Urethroscopy revealed no abnormal findings. Number 6 F catheters were introduced without obstruction to 25 cm. The left kidney urine was hazy amber and contained very many red blood cells. Phenolsulfonphthalein excretions were normal. Urine cultures produced no growth. Retrograde pyelography revealed a filling defect in the pelvis of the left kidney producing a smooth compression of the left pelvis and calyces. The left ureter was moderately dilated in its entire extent. The right side was normal. Confirmatory intravenous urography revealed the same filling defect.

A tentative diagnosis of papillary tumor of the left renal pelvis was made and on August 24 a nephrectomy and partial ureterectomy were performed. Further operative procedure was deemed inadvisable at this time because of the patient's poor general condition. Convalescence was rapid and uneventful. The wound healed by primary intention and the patient was discharged to the clinic on the thirteenth postoperative day. Three months later the patient was readmitted to the hospital for an elective ureterectomy. His general condition had, in the mean time, improved considerably. Cystoscopy now revealed a normal bladder. Most interesting of all was the apparent complete occlusion of the left ureteral stump. Because of this and since there was no evidence of recurrence, it was decided not to perform this surgical procedure. The patient since has been very cooperative and has revisited the Out-patient Department on many occasions. As far as we are able to tell he is entirely well.

The kidney measured 12 by 6 by 4.5 cm. The capsule stripped with ease. Fetal lobulations are present. The pelvis showed only a minimal amount of dilatation. Liquid purulent material was present and in the widest portion of the pelvis, almost directly in the center, there was a filamentous, friable mass measuring 2 by 2 by 1 cm. Its base was attached to one side of the pelvis while the apex partially obstructed the ureter. The ureter was markedly thickened.

Microscopically, the section through the tumor mass and pelvic membrane consisted of multiple axes of connective tissue covered by several layers of transitional epithelium which was uniform in size, shape and staining characteristics. There was no infiltration, bizarre-shaped cells or mitotic figures. The pelvic membrane was somewhat thickened and fibrosed and there was a minimal amount of round cell infiltration.

Diagnosis: Papilloma of the renal pelvis.

CONCLUSION

A case of papilloma of the renal pelvis is herein reported. The only symptom noted was one episode of silent hematuria. Nephrectomy and partial ureterectomy have apparently produced a satisfactory result although it is still too early to determine the subsequent events in this case.

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A major revolution regarding many theories in the virus field is under way, and it is believed that the upheaval will produce advances in general knowledge as well as an improvement in man's physical and economic well-being.

From—"The March of Medicine"—New York Academy of Medicine (Columbia University Press).

PREVENTION OF ACUTE URINARY RETENTION FOLLOWING ANORECTAL AND PERINEAL SURGICAL PROCEDURES*

IRVING HELFERT, M.D. AND EMIL GRANET, M.D.
Chief Resident of Urological Service, Sea View Hospital
BROOKLYN, NEW YORK
Director of Proctology, Sea View Hospital
NEW YORK, NEW YORK

ACUTE urinary retention is a frequent and troublesome complication following anorectal and perineal operative procedures. It is particularly so in male patients. Acute urinary retention severe enough to require catheter relief occurred in fifty-seven of a consecutive series of one hundred operative cases, sixty-eight of which were anorectal and thirty-two perineal urological procedures. Catheterization was resorted to only after failure of conservative methods to stimulate spontaneous micturition such as running water from a tap, perineal heat, standing out of bed, etc.

Inasmuch as the urinary bladder, anus and perineum are closely associated through the interrelationship of their motor and sensory nerve supply (the lumbosacral plexus), bladder dysfunction may result following operation in the anoperineal region. Powerful afferent stimuli originating in the pain sensory fibers of the operative wound probably cause aberrations in efferent motor stimuli which, reaching the bladder, results in the dysfunction manifested as retention. Briefly considered, the actual mechanism of retention consists primarily of atony of the involuntary muscle of the bladder wall (detrusor muscle) and possible spasm of the voluntary musculature surrounding the deep urethra (external sphincter). Increase in the tone of the detrusor muscle will cause contraction of bladder wall and increase in intravesical urinary tension. When the intravesical tension becomes sufficiently high, resistance of the internal and external sphincters are overcome, spontaneous micturition ensuing throughout the period of continued vesical contraction.

Woodruff and Te Linde recently reported a method of successful prophylaxis of postoperative retention in a large series of gynecological patients. After operation a 0.5 per cent aqueous mercurochrome solution was instilled into the bladder per catheter with the result that 93.4 per cent of their patients voided spontaneously after an average of five and one-half hours. In a control series (no mercurochrome) postoperative catheterization was necessary in 51 per cent.

The rationale of this treatment depends on stimulation of the sensory mechanism of the bladder wall by the chemical, mercurochrome. This stimulation acting as a counterirritant prevents atony and stimulates contraction of the detrusor muscle in the bladder, intravesical tension increases and spontaneous micturition results.

The striking results of Woodruff and Te Linde induced us to institute this method on our proctological and urological services at Sea View Hospital. Consequently, on conclusion of the operation and before the patient is removed from the table, 30 cc. of a 0.5 per cent aqueous solution of mercurochrome is instilled into the bladder per catheter. Precautions against the possibility of mistakes must be taken by having the 0.5 per cent aqueous mercurochrome specially labeled in a specially shaped bottle and poured into the measuring glass under the direction of the operator. An alcoholic solution of mercurochrome was mistakenly utilized in one early case resulting in a severe cystitis.

*From the Proctological and Urological Services, Sea View Hospital, Staten Island, New York.

One hundred forty patients were treated postoperatively with mercurochrome instillation as described. Of one hundred patients with anorectal operative procedures for perianal and ischiorectal abscesses; fistulectomies and hemorrhoidectomies, only one developed postoperative retention and required catheterization. Forty patients had orchidectomies, epididymectomies and hydrocelectomies. All voided spontaneously. Caudal block anesthesia with 2 per cent procaine was utilized in most cases. Sea View Hospital is devoted solely to the care of tuberculosis. Operative resections were extensive as lesions consisted mostly of perianal and perineal urological tuberculosis.

SUMMARY

One hundred forty patients underwent anorectal or perineal urological operative procedures. On completion of operation, 30 cc. of a 0.5 per cent aqueous solution of mercurochrome was instilled into the urinary bladder. Acute urinary retention requiring catheterization occurred in only one case (0.8 per cent). In a previous series of one hundred similarly operated cases in which no mercurochrome was used, acute urinary retention requiring catheterization occurred in fifty-seven.

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Case Reports

BULLET WOUND OF LEFT CARDIAC AURICLE WITH SUTURE AND RECOVERY*

A REVIEW OF THE LITERATURE

S. THOMAS GLASSER, M.D., F.A.C.S.,
Associate Surgeon, Metropolitan Hospital

WALTER MERSHEIMER, M.D.
Resident in Surgery, Metropolitan Hospital

AND

IRVING SHINER, M.D.
Resident in Thoracic Surgery, Metropolitan Hospital

NEW YORK, NEW YORK

WE present a rare case of gunshot wound of the heart involving the left auricle. An exhaustive search of the literature fails to reveal an instance of bullet wound of the left auricle with operation and recovery. The application of surgery to heart wounds has been, in the main, limited to knife or ice pick trauma cases. Because of the proximity of the left auricle to the pulmonary artery, aorta and root of the lung, bullet wounds in this region are invariably fatal, death being almost instantaneous. Of further interest in this case are the serial electrocardiographs depicting the pathological changes involved.

REVIEW OF THE LITERATURE

Incidence and Types. Heart wounds are uncommon. The trauma is usually caused by a knife or ice pick. In Elkin's[22] series of twenty-two cases, fifteen were knife wounds and seven ice pick in origin. He states that, "no cases with gunshot wounds of the heart have been treated, for the reason that they usually die from hemorrhage before reaching the hospital." A bullet usually causes two wounds: entrance and exit, and greater destruction. Bigger[4] and others also report that most patients with penetrating wounds of the heart who are operated upon present stab wounds. On the other hand, an isolated injury to the pericardium, is more rare than an injury to the heart. According to Ginzburg and Sarkisov,[12] the ratio is 1:10. Isolated pericardial injuries are less apt to occur for the following reasons (Kosmin[13]): cardiac activity, point of entrance, character of the instrument (bullet wounds not likely), direction, and the degree of penetration. Most cases of penetrating heart wounds are complicated by pleural injury, hemothorax, pneumothorax or combinations of all. For the purpose of classification of heart wounds, Bigger[3] suggests in effect the following: (1) Pericardial injury alone, or pericardium plus heart wall without penetration into heart chambers, or divisions of important coronary vessels. These are difficult to diagnose and usually do well without operation. (2) Severe injuries—death before surgery can be performed—gunshot, etc. (3) Penetration into heart chambers or coronary artery injury—diagnosis not difficult because tamponade is usually present; if not, as in a case in

* From the Department of Surgery, New York Medical College, Flower and Fifth Avenue Hospitals. Surgical Service of Metropolitan Hospital.]

which the opening between the pleural and pericardial cavities is large enough to allow for leakage of blood, absence of tamponade may make diagnosis difficult. Nevertheless, surgery is indicated if injury is in the cardiac region and there are signs of intrathoracic hemorrhage. Statistics approximate the location of heart wounds which come to operation as 55 per cent in the right ventricle, 35 per cent in the left ventricle, and 10 per cent varied or combined.

Mortality and Morbidity. The mortality is dependent upon the type and location of the wound. Most statistics refer to stab wounds. The lowest mortality for an individual collection of cases may be credited to Bigger[4]—twenty-five cases with a mortality rate of 36 per cent, of which only two were bullet wounds (both in the ventricle, with one recovery). His mortality ranged from 29.5 per cent for right ventricle wounds to 100 per cent for pulmonary artery plus ventricular injury. In response to a questionnaire the same author noted a mortality of approximately 50 per cent in 141 cases. Nissen[21] also found the same mortality from collected statistics. Elkin's[22] formidable list of twenty-two cases likewise presented a 50 per cent mortality. Mayer[27] makes the observation that, "Cases reported treated conservatively in previous years show that only 10 per cent to 15 per cent recovered." Elkin[23] finds that the prognosis is 80 per cent recoveries in right ventricle wounds (easier to suture, etc.), while the high mortality in auricular injury can be attributed to the difficulties involved in the approach and suture of the thin-walled auricle. Because death may occur from hemorrhage, tamponade or both, early operation is important. Bigger[3] is also of the opinion that, "The prognosis depends not only on the type of injury, but also on the promptness with which surgical aid is given." The majority of Bigger's patients who recovered were operated upon within three hours of the time of injury. In one case, operation was successful six to seven hours after a knife wound.

Without exception, it is agreed that the chief cause of death postoperatively is infection. Elkin[23] notes that in 75 per cent of operations with a fatal outcome, the cause of death is either pneumonia or purulent pericarditis. Bigger[3] lists the most frequent postoperative complications: infection, pulmonary infarction and cardiac tamponade. On considering the preventable causes of death, Singleton[19] mentions in the order of their importance: hemorrhage, tamponade and infection. Contrary to expectations, pericardial adhesions do not seem to cause any difficulty. According to Nissen's[21] collected statistics, pericardial effusion resulted in 40 per cent of all cases in spite of the fact that his observations failed to reveal even one instance in which the pericardium had closed spontaneously. Peculiarly enough, the late results showed that the functional disturbances when present, were nearly always respiratory instead of cardiac. This point has been emphasized by LeFort and Decoulx who noted the results in fifty-five cases seen after more than twenty years. They state that "Even in cases in which the lesion involved the myocardium, pericardium, large vessels or the cardiac nervous plexus, the circulatory system was surprisingly little affected . . . and that the electrocardiograms (16 cases) were invariably normal or nearly so 20 years after the original trauma." Hesse[7] reports a case of bullet wound of the left ventricle with successful suture, in which after twenty-six years, there was no cardiac difficulty, but dyspnea was present on marked exertion.

Mechanism. Under normal conditions, the intrapericardial pressure is below atmospheric pressure and it is probable that there is a negative pressure in the venae cavae within the thorax (Elkin[23]). Furthermore, an increase in the intrapericardial pressure necessitates a rise in the venous and fall in the arterial pressures. Progression in this direction leads to circulatory collapse. Bigger[4] finds that the patient will develop a temporary circulatory adjustment with general improvement following a favorable response to the origi-

nal circulatory collapse. This response is summarized by Elkin: "an increasing intrapericardial pressure must be overcome by an ever increasing venous pressure if the circulation is to be maintained." Following the injury, the heart bleeds into the pericardial or pleural cavities and externally. Pericardial distention occurs when 100 to 200 cc. of blood accumulates. This is the beginning of a vicious cycle. As the intrapericardial pressure increases the venae cavae become unable to pour sufficient blood into the heart. Furthermore, the emptying capacity of the heart also decreases. Finally, progressive cerebral anemia results in death. During the present Sino-Japanese war, Ransom[17] observed 150 cases of chest wounds. He found that the presence of pneumothorax was most significant in its mechanism on the thoracic contents. Because of the effect of mediastinal flutter on the great veins by producing intermittent pressure on the venae cavae, cardiac difficulty was further aggravated in addition to that due to the heart wound itself. Tamponade may be absent where there is an opening between the pericardial and pleural cavities. The size of the heart wound and the rate of blood flow also determine the rapidity with which death may ensue from hemorrhage. Another condition which may lead to a fatal outcome is tension pneumothorax. Here, the pleural pressure advances towards a positive value. Therefore, it becomes imperative that the pleural pressure be reduced. Collapse of the lung will be in direct proportion to the degree of hemothorax, and hemorrhage will tend to stop when the pressure of fluid (blood) reaches a corresponding level (with the exception of injuries near the hilus). The advisability of aspiration of blood in instances other than in those in which pressure symptoms are present, is controversible. However, when aspiration becomes necessary, replacement with air is usually of value. Air not only serves to allay bleeding from the lung but also is beneficial because of its "cushion-like" effect and more equalized pressure, thereby permitting healing. Some surgeons believe that complete aspiration with air replacement should be routine because of the danger of infection, autogenous or otherwise, in which fluid serves as a good medium for bacterial growth.

Diagnosis. A precise history is valuable in making a diagnosis of heart injury but in most instances is not obtainable. Elkin[24] stresses that a "—history of a symptomless interval, similar to that seen in intracranial hemorrhage, during the time the pericardium fills with blood, is the most important point in the history." During the present Sino-Japanese and Spanish Civil Wars, Sellors[16] has observed one syndrome which is common to all chest wounds, that is, shock and dyspnea. The presence of bleeding is shown by an increasing pulse rate. The usual sign of air-hunger present in hemorrhage, may be unnoticed because breathing is difficult. Vakhrameev[18] observed a pulse irregularity in four out of seven cases. Without tamponade, the diagnosis of heart injury may be difficult. The signs of tamponade are, a low or unobtainable blood pressure, weak, rapid or absent radial pulse, distant and muffled heart sounds, increased venous pressure with distended veins in the neck, marked dyspnea, pallor, cyanosis and fluoroscopic examination with absent or markedly decreased cardiac pulsation.

Most authors agree that fluoroscopy is of great diagnostic value. Constantini[15] claims priority for the use of fluoroscopy in determining the presence of hemopericardium—immobility of the heart in addition to enlargement. The *x*-ray is usually of little aid unless the hemopericardium is marked and pleural fluid is absent—a rare combination. Furthermore, according to Hegner, the *x*-ray is of value only if taken in the erect position; this is not permissable during the first twenty-four hours. Kosmin[13] points out that an isolated pericardial wound may be asymptomatic because pericardial injury alone does not cause pain and heart activity may not be altered. However, a hemopericardium may occur in the

presence of an isolated injury to the pericardium. If this prevails, differentiation may be difficult. Tamponade is more intense and rapid in heart injuries. Bigger was able to confirm the diagnosis of tamponade in thirteen cases of his series. Ginzburg and Sarkisov[12] list the symptoms of isolated pericardial injury as: hemorrhage from the wound, dyspnea, increased area of cardiac dullness, clear heart sounds and temporary and insignificant symptoms of compression of the heart. Pain depends on the presence of injury to the ribs. Venous pressure, normally ranging between 7.5 and 12.5 cm. of water has been recorded as high as 40 cm. The duration of an elevated pressure prognosticates a fatal issue. Sellors[16] found that in cases of projectile injuries, a small exit wound indicates that no bone has been encountered.

In lung injury, cough may be troublesome. Hemoptysis is variable in degree and when present is a pathognomonic sign of lung injury. This sign is frequently delayed. In a hemopneumothorax, the volume of air and blood are inversely proportionate. Hegner's[1] observations concerning hemopneumothorax are most interesting. He finds that slow bleeding with an associated smaller accumulation of blood, reduces the chances of clotting because the lapse of time allows for fibrin precipitation with tissue and pleural reaction, thereby modifying the blood, and preventing clotting. On the other hand, when marked hemorrhage occurs, there is no time for precipitation and tissue reaction, so that blood coagulation results and absorption follows slowly. This is the reason why the blood obtained from a marked hemorrhage may be used for autotransfusion, i e., unaltered blood. Aspiration may then serve as a diagnostic test for massive and recurrent bleeding wherein the blood is found to coagulate. Since the initial blood found in a hemothorax is sterile, since absorption allows for early lung re-expansion with the danger of added hemorrhage, and since late hemorrhage may be contaminated and bacterial growth likely to occur in a suitable medium, all of this, makes aspiration with immediate replacement by artificial pneumothorax an advisable therapeutic precautionary measure. The continuance of fluid and its accompanying pleural reaction permits for lasting adhesions. This is another argument for complete aspiration with pneumothorax. Partial aspiration as practiced by some, still leaves open the possible complications mentioned above. Schlomka[28] states that, "air does not embarrass to the same degree as fluid, the retractile power of the opposite lung."

Elkin[22] makes an emphatic statement when he writes that although death from hemorrhage may occur without tamponade, he has never observed this in any case.

Electrocardiography in the diagnosis of heart wounds has little if any value because, commonly, the tracings are normal for many hours following the trauma or suture. Its value comes later when the degree of infarction or progress in healing is to be ascertained. Koucky and Milles[20] collected the tracings from thirteen cases in the literature. These electrocardiographs were of no value in localizing the site of heart injury, and failed to picture ligation of the coronary arteries when this procedure had been performed. They concluded that, "a return to a normal curve apparently occurs ultimately in the vast majority of cases." In Nissen's[21] four cases, the electrocardiograms returned to normal after ten days. Morris[17] noted a normal tracing three and six weeks postoperatively.

Treatment. In outlining the treatment of heart wounds, Bigger[2] classifies his cases into 4 types as follows: (1) Those in which there is free communication with the pleura but only slight or moderate hemorrhage—treat conservatively. (2) In those cases in which tamponade is present but improvement is marked (rise in blood pressure, etc.) following venoclysis, adrenaline and morphine, patients are prepared for operation. The pericardium is aspirated through a cannula to lower the intrapericardial pressure. With the cannula left in situ for fifteen to thirty minutes, renewed bleeding

is watched for. The prompt re-appearance of tamponade is an indication for immediate operation, otherwise conservatism is followed. (3) When there is a marked increase of intrapericardial pressure without a satisfactory response to conservative treatment such as a continued low blood pressure, immediate operation is indicated. (4) When there is free communication with the pleura in addition to massive intrapleural hemorrhage, immediate operation plus autotransfusion is indicated. There is a high mortality in these cases.

In general, treatment varies between two extremes. Desjacques and Clert[10] recommend immediate surgical exploration in all open wounds of the chest made by a knife or bullet. Cox[29] treated tamponade in his case by repeated aspirations (five) with recovery. Singleton[19] believes that aspiration of the pericardium may be performed for temporary relief, or in preparation for operation in some instances, and in addition may serve as a curative therapeutic measure. Morris[17] and Elkin[22] believe that immediate operation is essential when tamponade is ascertained, while in the patient in extremis, it may be a life-saving procedure. He also advises against the use of intravenous fluids because of the danger of increasing an existing tamponade. The application of external heat and the administration of morphine should be instituted in all cases. A propped-up position is usually more comfortable for the patient, i.e., coughing and dyspnea are alleviated and the incidence of atelectasis is decreased. The oxygen tent is another important therapeutic measure. It relieves dyspnea and cyanosis and improves the pulse and blood pressure. While pneumothorax is often beneficial in the control of pulmonary hemorrhage, a tension pneumothorax must be watched for and is easily overcome by releasing air through an aspirating needle connected to a tube led under water in a bottle. Blood transfusion is of greatest importance postoperatively to combat shock and hemorrhage. Watson and Watson[8] claim to be the first to use autotransfusion successfully in a case of heart wound. There is no doubt that this is an expedient and practicable measure. Elkin[22] recommends an autotransfusion of citrated blood during or immediately after the operation as the case requires. Under discussion in Singleton's[19] paper, Dr. R. L. Rhodes presented two cases in which the blood was aspirated during the operation, filtered and injected into a vein or directly into the ventricle.

The choice of anesthesia varies with the pathology present and the patient's general condition. Elkin[23] prefers nitrous oxide inhalation anesthesia to local anesthesia because positive pressure is needed to inflate the lung if the pleura has been opened either by the wound or during the operation. Furthermore, he believes the difficulties encountered in heart suturing are increased by a struggling patient especially so as commonly occurs after the tamponade has been released. Bigger[3] states that, " . . . if a transpleural approach is to be used, a general anesthetic administered under slightly positive pressure is preferable; but if an extrapleural approach is planned, a local anesthetic is entirely satisfactory." In nearly all of Vakhrameev's cases, the author employed ether anesthesia.

There is a unanimity of opinion on the paramount importance of strict asepsis throughout, since all agree that infection is the most common and dangerous postoperative complication.

Débridement of the knife or bullet wound is a further added precaution against infection. This applies particularly to knife and ice pick wounds.

It has been pointed out that no one method of operative approach is suitable for all cases of heart injury. A commonly used incision is one which forms a flap with its convexity toward the left border of the sternum and includes the interval between the third and fifth ribs. A good exposure with minimum trauma is essential. Whenever possible in those cases in which the pleura has not been injured, an extrapleural approach should be made. Opening

a sound pleura increases shock and adds the danger of infection. Elkin[23] with his extensive experience usually finds that the best approach to the heart is to the left of the sternum, except in those cases in which the entrance of the wound is located on the right side. His incision is planned at all times to allow for enlargement of the operative field. He finds that a long transverse incision extending across the sternum allows for the removal of one or two ribs and where necessary the adjoining cartilages or part of the sternum. There is less danger of injury to the pleura when the rib is cut first and displaced from its periosteal covering followed by removal of the corresponding cartilage. The next step includes division of the internal mammary vessels and triangularis muscle. Lateral displacement of the pleura by gentle gauze and finger dissection is the next important step. The transverse incision is less shocking and less time consuming than the convex flap method previously mentioned. Constantini[15] believes that the best approach is to resect the cartilage closest to the wound which gives pericardial exposure, and then to enlarge the exposure depending upon the need. However, he usually makes a flap with its convexity medially and exposes the cartilages, then resects the left border of the sternum and also the right border of the sternum opposite the fourth intercostal space if necessary. Additional cartilages may be removed as required to enlarge the field. He observes that visibility is chiefly obscured by the left border of the sternum which he always resects so as to be better able to examine the right auricle.

The pericardium which now comes into view will be found bulging and blue if tamponade is present. If the rent in the pericardium is easily found, the opening is enlarged, otherwise it is opened between stay sutures. The contents are aspirated. Wiping is not advisable because with this added trauma, effusion will ensue to a greater degree than usually occurs. Later, the pericardial sac may be flushed with saline. The hemorrhage from the heart wound must be put under control immediately. This is facilitated by placing the tip of the index finger *on* the wound (Elkin)[23] not *into* the wound because of its friability, and a suture of black silk is passed under the finger. This suture serves for both traction and hemostasis and allows for the necessary time to place additional sutures. Precautions to be taken at this stage are, to avoid entering the heart chamber with suture needle and to avoid the application of too much tension on the ties. A traction suture applied to the apex of the heart as advocated by Beck[25] and endorsed by Bigger,[4] serves not only to control hemorrhage and facilitate the placing of sutures at the site of the wound, but also for visualization of trauma on the lateral and posterior cardiac areas by rotation traction. Interrupted sutures, widely spaced, are used to close the pericardium. Since pericardial effusion is inevitable because of the original trauma and irritation, a tight closure is not advisable. Bigger[4] warns against placing a drain into the pericardial sac and favors the introduction of widely separated sutures, or allowing the lower portion to remain open. Elkin[24] places a drain of soft rubber down to the pericardium and orders its removal in forty-eight hours.

Cessation of the heart beat or fibrillation during the operation sometimes occurs in association with apical traction or handling. This emergency is treated by stopping the operation and allowing the heart to recover. If this is not prompt, adrenalin (1 cc. of 1:1000) is injected into the myocardium and gentle cardiac massage is started. This procedure is often rewarded by a return of heart function. In many cases in which injury to the coronary vessels required ligation, the outcome was frequently uneventful. Elkin[23] states that a fatal termination would be expected in such cases in which the patient is old and in which there is pre-existing coronary sclerosis. It is of interest to note an observation which has frequently been recorded; that contrary to expectations, during operation

under local anesthesia, the ligation of a coronary artery is not attended by pain nor is there pain present during heart suture even when this procedure throws the heart into strong contractions.

Beck and Cox[9] conducted experiments on dogs to determine the effect of exposing the heart to atmospheric pressure. They found that the venous pressure was increased for a considerable time, the arterial pressure dropped 8 to 30 mm. of mercury, and the minute volume output of the heart decreased 15 to 30 per cent. When the opening was closed, the heart returned to normal. It was concluded that the atmospheric pressure acts as an air tamponade and causes a dilation of the pericardial cavity. The application of these observations to heart surgery are significant.

In view of recent knowledge on the subject of heparin, Bigger[4] has advocated its usage postoperative in cases in which the wound has penetrated the heart chambers or injury to the coronary vessels has been sustained. Further postoperative care includes the use of the oxygen tent, Fowler's position for easy breathing and morphine for proper rest. The development of increased intrapleural fluid associated with pressure symptoms will require aspiration. Infection may necessitate rib resection for drainage. A close watch must be kept on the pleural and pericardial reaction, and indicated therapy instituted when the situation arises.

CASE REPORT

A. W., an eighteen year old white male, was brought to the Metropolitan Hospital by ambulance at 8:00 A.M. No history was obtainable; the patient was comatose and in profound shock. History given subsequently was that the patient had shot himself with a .22 caliber pistol at 2:00 A.M., six hours before admission to the hospital. Examination revealed a young male apparently in coma and shock, skin of face pale and cyanotic, in a cold sweat, and respirations slow, shallow and labored. There was a marked strutting of the veins in the neck and arms. The radial pulse was imperceptible and the blood pressure could not be ascertained. Examination of the chest revealed a small, round wound ½ cm. in diameter located about the fourth interspace and 2 cm. medial to the midclavicular line. The wound was not bleeding and there was a large amount of clotted blood on the skin and clothes. A darkened area which had the appearance of a burn similar to that of powder marks, encircled the wound. Posteriorly at the lower angle of the left scapula (Fig. 6), there was another small wound of about the same size and description except for the absence of a burn, probably the point of exit. On auscultation, the heart sounds were barely audible and muffled. The left side of the chest was flat to percussion and devoid of breath sounds. A diagnosis of bullet wound of the left chest with cardiac tamponade and lung injury was evident. With the patient still on the stretcher, a portable *x*-ray of the chest was obtained. (Fig. 1.) This was inconclusive except for evidence of diffuse clouding throughout the left lung field. The stretcher was wheeled into the operating room and to avoid disturbing the patient, it was decided to use the stretcher in place of the operating table. Skin preparation consisted of shaving, green soap scrub, benzine wash and tincture merthiolate. Tamponade was confirmed by aspiration of blood through the fourth interspace at the left margin of the sternum. Operation started at 9:00 A.M. Infiltration novocain anesthesia served to block the precordial area from the sternum to the left anterior axillary line and from the second to the sixth ribs. Inhalation of oxygen under positive pressure was maintained. A curved skin incision (Fig. 5) was made with its convexity touching the left margin of the sternum, starting at the third rib in the midclavicular line and terminating at a corresponding point on the sixth rib. The incision was deepened through the skin, fascia and pectoralis muscle, thereby exposing the fourth, fifth and sixth ribs, and the soft tissue flap was freed lateralward. The fourth and fifth costal cartilages were severed about 2 cm. from the left sternal margin and were then resected laterally for approximately 10 cm. The substernal muscle and fascia were opened and also retracted to the left thereby exposing the pericardium. On opening the pericardium about 500 cc. of blood escaped under pressure. With the aid of suction, the field was cleared and an actively bleeding perforation was noted on the margin of the left

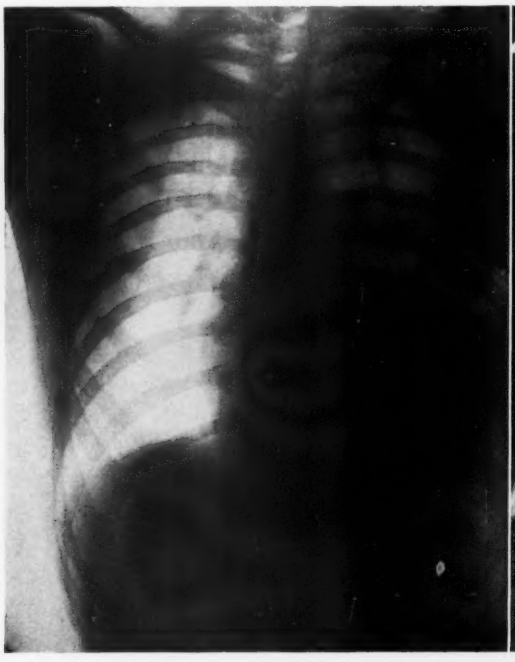


FIG. 1. The heart and mediastinum appear to be in the midline. There appears to be fluid in the left pleural cavity, September 20, 1940.

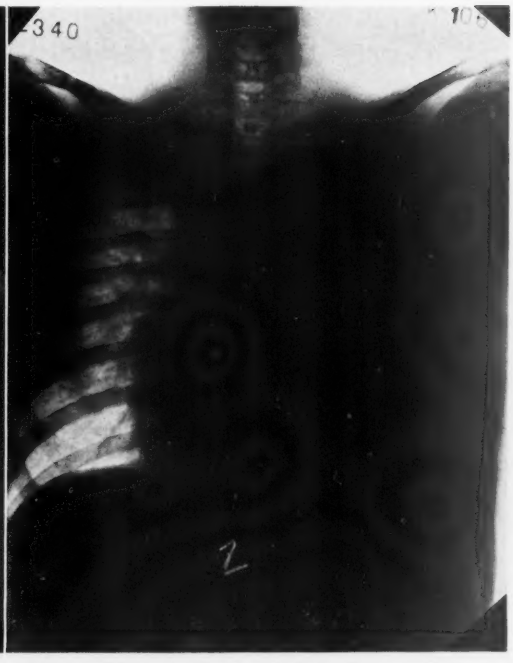


FIG. 2 Pleural effusion in left chest and congestion in the right lung field, September 23, 1940.

FIG. 3. There is further diminution in the amount of fluid in the left pleural cavity. The mediastinum and contents appear to be approaching the midline, October 2.

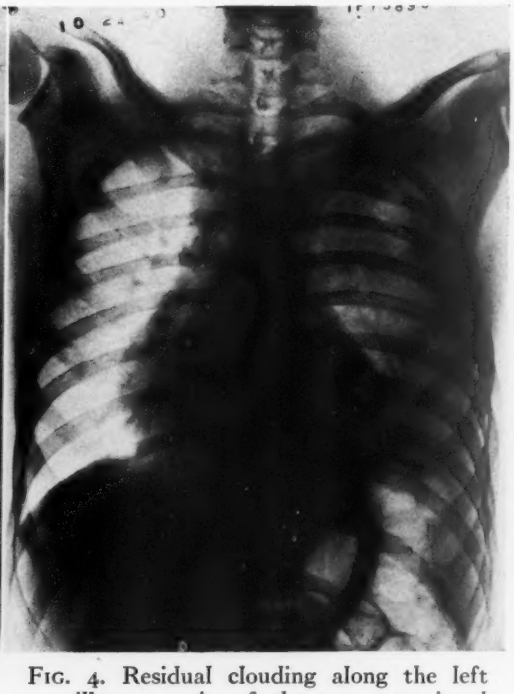


FIG. 4. Residual clouding along the left axillary margin of the type associated with possible plastic exudate. The heart shows no definite abnormality, October 24.

auricle close to the auriculoventricular junction. The pleura and overlying lung had also been penetrated by the passage of the bullet

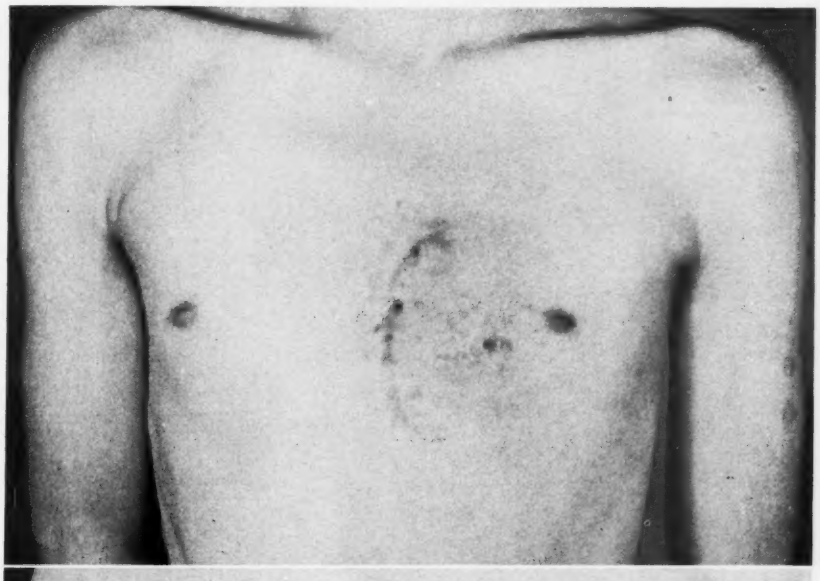


Fig. 5.

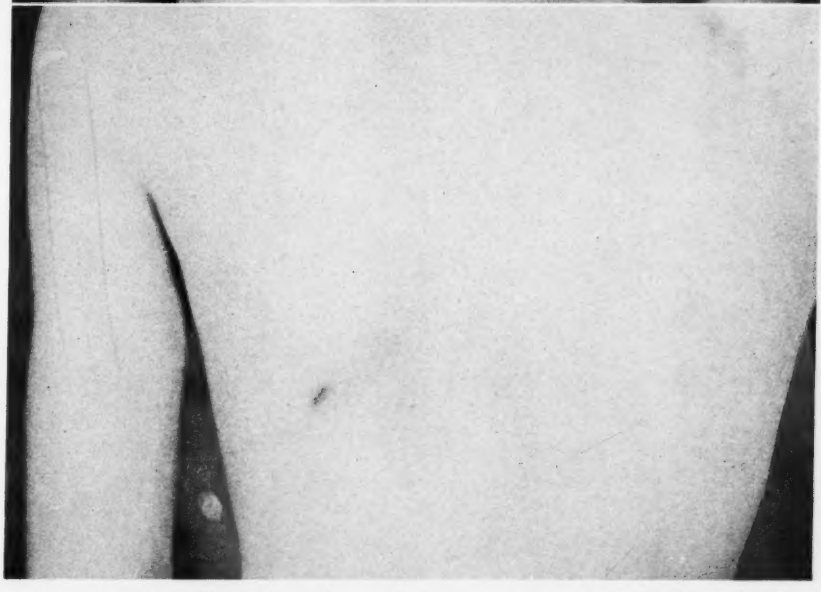


Fig. 6.

Fig. 5. Healed incision and site of entrance wound, November 6.
Fig. 6. Exit wound at inferior angle of scapula, November 6.

and the lung seemed to be completely collapsed. Hemorrhage was readily controlled by light digital pressure. A small tab of adipose tissue in close proximity to the heart wound was grasped with an Allis clamp which served in the capacity of a stay-suture, thereby facilitating the placing of a mattress suture of chromic No. 0 catgut which included the fat tab. This was all that was needed for complete hemostasis and closure. Interrupted No. 0 plain catgut sutures were used to close the pericardium (except at its lateral border) and to approximate the layers of the chest wall to their original position. The skin was closed with interrupted black silk sutures. The entrance wound was excised "en bloc" and later closed with one black silk suture.

Postoperative treatment consisted of shock therapy: heat and morphine, oxygen through a B.L.B. mask (followed later by an oxygen tent), and autotransfusion of 400 cc. of blood. This had been aspirated from the left pleural cavity, then citrated and strained through sterile

gauze. Desoxycorticosterone acetate (cortate 1 cc.) and 3,000 units of tetanus antitoxin were given. Pleural decompression for relief of tension hemopneumothorax was obtained by inserting a needle into the fourth interspace in the anterior axillary line, leading the connecting tube under water to a bottle placed on the floor. This procedure revealed the presence of tension, as evidenced by the escape of air under positive pressure. The immediate postoperative arterial pressure was 100/50 and pulse 120 of good quality. This was maintained and the blood pressure rose to 170/76 in four hours, but returned to within normal limits in two hours; 7:00 P.M., pressure 100/50, pulse 126, respirations 26; 10:00 P.M., pressure 100/60, pulse 124, respirations 40. Within twelve hours the patient had reacted well enough to take large amounts of fluid by mouth.

An electrocardiograph (Fig. 7*a*) taken within a few hours after operation was interpreted to present a right axis deviation probably due to pulmonary hypertension secondary to pneumothorax. In anticipation of infection, sulfanilamide (20 gr.) and sodium bicarbonate (20 gr.) were started immediately and given every four hours for twenty-four hours to be reduced to 15 gr. every six hours for the second and third days. Fluid intake for the first twenty-four hours was 6,500 cc., output, 600 cc.

On the morning of the second postoperative day, the patient was in a semicomatose state although the blood pressure, pulse and respirations remained unchanged. The temperature ranged between 100 and 101 degrees. A sanguineous discharge persisted in the drainage through the aspiration needle. In the afternoon, the blood pressure was 108/64 and pulse 128

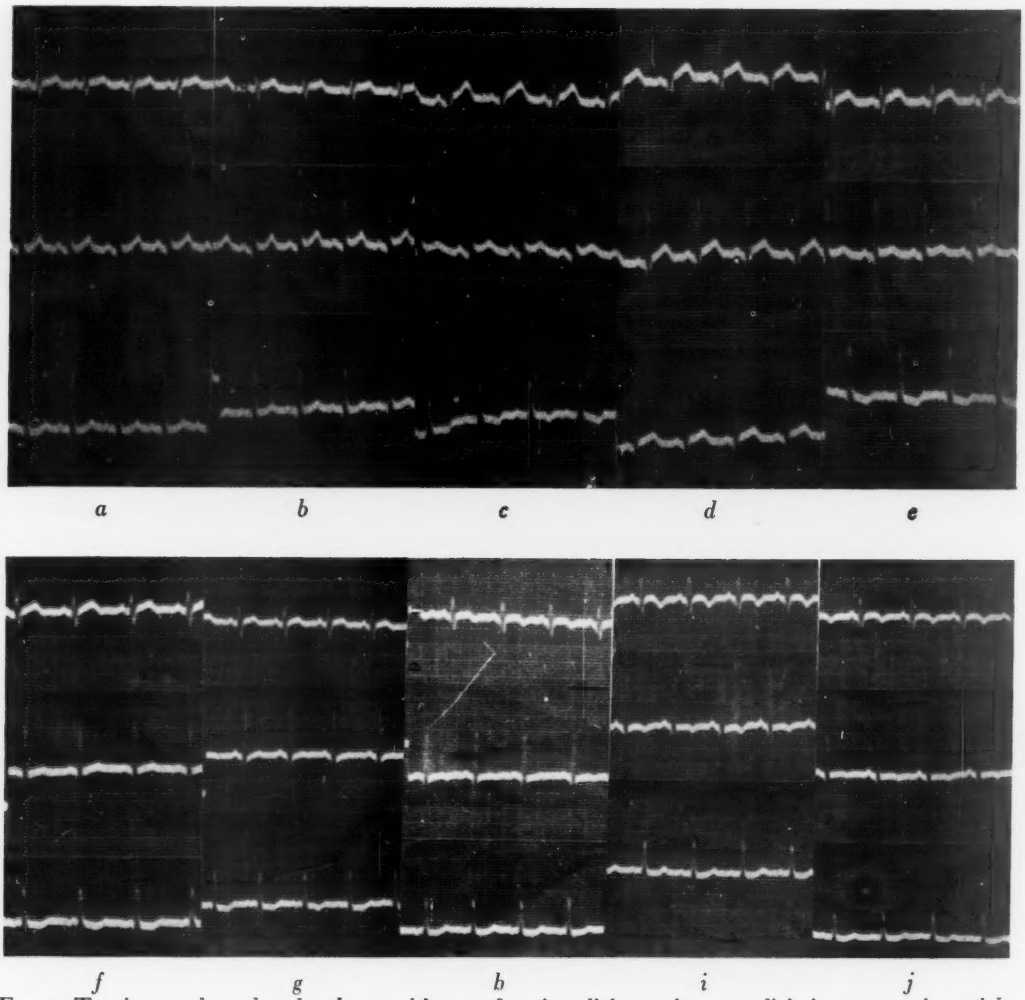
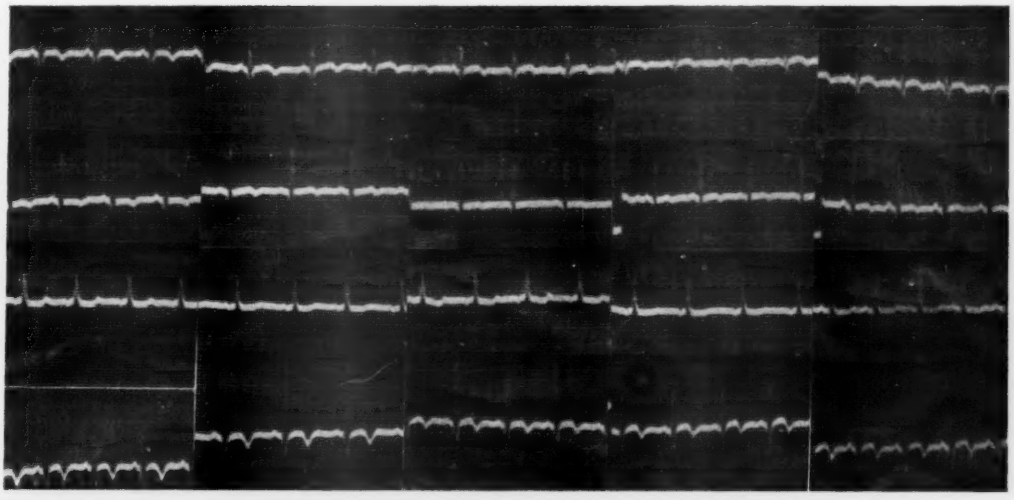
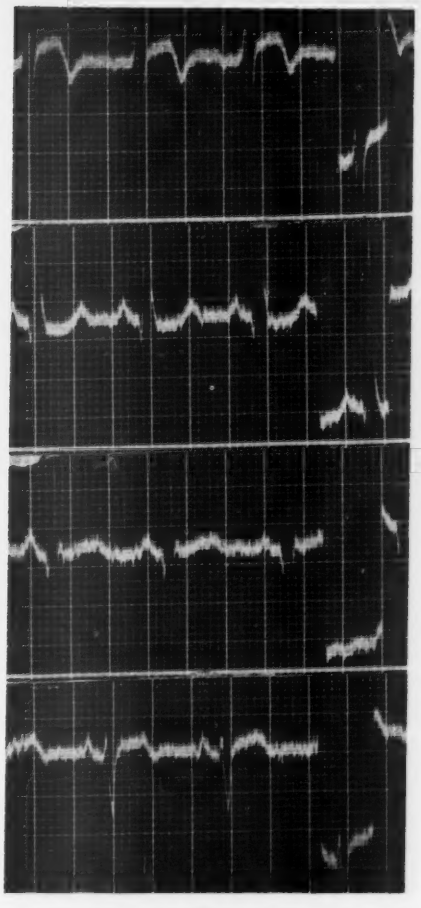


FIG. 7. Tracings *a*, *b*, *c*, *d* and *e* show evidence of pericarditis; perimyocarditis in progression with signs of healing apparent in *f*, *g*, *h*, *i* and *j*.



k *l* *m* *n* *o*



p

FIG. 8. *k*, *l*, *m*, *n* and *o* continuation of sequence as depicted in Figure 7. *p* shows right axis deviation and changes as seen in myocardial infarction when healing. Compared with the preceding tracings, the S1 is deeper, T2 is upright, ST3 is more depressed, T3 is more upright, R4 is now positive and S4 is deeper.

The patient became irrational. This was controlled by barbiturates. The venous pressure was 24 cm. at 1:00 P.M. and 20 cm. at 3:00 P.M. A transfusion of whole blood (300 cc.) was given preceded by 0.5 cc. of cortate to be repeated twice daily for the next few days. In the evening, the temperature had risen to 103.4 degrees, pulse 120, respirations 32, and blood pressure 110/66.

On the third postoperative day—6:30 A.M., the temperature was 103.4 degrees, pulse 124, respirations 28 and blood pressure 106/66. The patient was still irrational although occasionally lucid. The pneumodecompression drainage functioned satisfactorily with evidence of slight active intrapleural bleeding. By noon, the temperature was 102.8, pulse 120, respirations 32 and venous pressure 16 cm.

On the fourth postoperative day—8:30 A.M., the temperature was 103.5 degrees, pulse 122, respirations 36, blood pressure 116/66 and the pneumothorax drainage bottle still showed slight evidence of bleeding. In the evening, improvement became apparent. The pulse was 100, temperature 100 degrees and venous pressure 10 cm. Another blood transfusion (250 cc.) was given. The patient was rational. *X*-ray of chest (Fig. 2) indicated the presence of fluid in the left chest but no shifting of the heart or mediastinum.

On the fifth postoperative day, the general condition was fair: venous pressure 11 cm.; urine normal; blood—hemoglobin 54 per cent, red blood cells, 2,470,000; white blood count 15,000; polymorphonuclears 66 per cent; blood chemistry normal. Chest *x*-ray (Fig. 3) showed displacement of the cardiac shadow to the right and clouding of the left lung field due to effusion in the left chest.

On the sixth postoperative day, the temperature was still elevated (102 degrees); pulse 113; venous pressure 11 cm.; respirations 36 and blood pressure 106/52. The patient was rational and his condition fair. The dressing was changed, and a fluctuating area was noted in the center of the incision over the fourth rib. Probing released 30 cc. of green, thick, purulent exudate—smear showed many pus cells and Gram positive cocci in diplo and chain formation; culture subsequently revealed Streptococcus hemolyticus. A rubber drain was inserted into this superficial infection. Streptococcus vaccine was given intramuscularly (0.1 cc.) and 0.5 cc. on the two succeeding days. Sulfanilamide was discontinued because of the low hemoglobin and red blood count. An electrocardiograph (Fig. 7*c*) showed evidence of pericarditis.

On the seventh postoperative day the temperature was at a lower level (100.2); pulse 88; respirations 40; venous pressure 15.5 cm.; blood pressure 106/60. Dyspnea was present without cyanosis. *X*-ray of the chest (Fig. 4) revealed an increasing enlargement of the cardiac shadow with the right border of the heart filling one-third of the right lower chest. This was thought to be either cardiac dilatation or pericardial effusion. The heart sounds at the apex were slightly muffled, but came through clearer over the sternal portion. Breath sounds in the left lower chest were absent—suggesting the presence of fluid. The character of the purulent discharge from the wound had changed from a thick, creamy consistency to a watery, sanguinous fluid. This evidence was in favor of the presence of a communication of the wound with the pericardium. A drain was inserted in the wound.

On the eighth postoperative day the temperature was still moderately elevated and dyspnea became marked. Aspiration of the left chest by suction resulted in the withdrawal of 850 cc. of serosanguinous fluid—negative for organisms on culture. The venous pressure then dropped to 11 cm; blood pressure 120/60. The patient was comfortable and improvement evident. The blood count showed improvement over the previous anemia—hemoglobin 64 per cent; red blood cells, 3,120,000. The electrocardiograms (Figs. 7*d* and *e*) indicated the presence of perimyocarditis.

The following month was not associated with any further complications. The temperature declined to normal levels within the next ten days; the venous pressures remained within normal limits. Drainage, apparently pericardial effusion, persisted until the wound healed in about three weeks. *X*-rays of the chest (Fig. 4) showed steady improvement. Electrocardiograms (Figs. 7*f*, *g*, *h*, *i* and *j*, and 8 *k*, *l*, *m*, *n* and *o*) evidenced some improvement in the perimyocarditis.

The patient was ambulatory on the forty-first postoperative day without any evidence of reaction and discharged from the hospital on November 9, 1940.

In a follow-up examination, November 30, the fluoroscope revealed diminished pulsation

at the ventricular apex, diminution of movement of the apex on respiration, diminution of movement of left diaphragm on respiration, size of heart within normal limits, good pulsations except at the apex and diaphragmatic attachment where the heart was immobile. The electrocardiogram (Fig. 8*p*) suggested changes as seen in myocardial infarction when healing. The patient had no subjective symptoms except for slight shortness of breath when walking on an upgrade. He had gained ten pounds, his appetite was excellent and he slept well.

DISCUSSION

On admission to the hospital, the patient presented sufficient signs of heart wound with tamponade to make an accurate diagnosis. Realizing that the time factor was all important in this case, and since the diagnosis was apparent, a venous pressure determination and fluoroscopy were omitted. The information derived from these two procedures would no doubt have completed the classical picture of the injury which has been so well described by Elkin, Bigger and others. The value of venous pressure determinations was illustrated on the seventh postoperative day. At that time, the clinical and laboratory reports indicated improvement in the patient's condition. But a rise in venous pressure and definite dyspnea gave warning of the presence of further pathology—tamponade and effusion. The withdrawal of 850 cc. of serosanguinous fluid from the chest resulted in a drop in venous pressure to a normal level with complete disappearance of the dyspnea.

This case also bears out the finding of most authors that subsequent disturbances are nearly always respiratory instead of cardiac. It is interesting to note that the time interval which elapsed before the patient was admitted to hospital was six hours. One can only speculate on the mechanism involved during this interval. Apparently, cardiac tamponade over a period of six hours would result in cerebral anemia and death would ensue. Furthermore, continued hemorrhage persisting over this period would also have a lethal issue. Of course, this would depend on the rate of blood loss and the size of the heart wound. However, it is our opinion that the opening between the pericardium and pleura was of a ball-valve mechanism. Decompression into the pleural cavity probably occurred whenever the tamponade pressure reached a sufficiently high level. This built-up positive pressure would overflow into the negative pleural pressure sac. As an added factor, shock aided in slowing the circulation—with increased blood viscosity and a concentration in the capillary bed.

Our electrocardiographic tracings were normal at first and then changed because of pericardial effusion, myocardial alterations and an increased pulmonary load. As the effusion was absorbed, the tracings pointed to instrinsic myocardial changes, since the electrical impulses were later transmitted more directly without interference from a layer of fluid. Thus the anterior-like infarct picture presented itself and the tracings showed regression and improvement.

This is the only case in the literature of gunshot wound of the left auricle in which operation was successful. Anatomical studies on the cadaver verified the path transversed by the bullet. Missing the pulmonary vessels, aorta and important structures in the hilum of the left lung was indeed miraculous. This confirms the repeated observations so often noticed concerning the erratic course of bullets through the body.

In retrospect, there is no doubt but that a transverse incision would have been less time consuming in the opening and closing and the technical facility aided. Another point in the technic worthy of note is to remember the difficulty encountered in the removal of the ribs when one first cuts the costal cartilage instead of the rib. The information derived from a portable *x*-ray picture was of only little help in the diagnosis. The possible prophylaxis against pleural and pericardial infection played by the short administration of sulfanilamide is problematical in our case. The value of

cortate in combatting shock may have been useful. Autotransfusion was a valuable therapeutic measure. The persistent temperature elevation was probably due to pleural and pericardial effusion, which has been found so frequently as an irritative response to trauma.

SUMMARY

We present a case of bullet wound of the left auricle attended by successful suture and a general review of the literature on the subject of cardiac trauma. The value of decompression of both the pleural and pericardial sacs have been emphasized. Autotransfusion is of inestimable value in combatting shock. Desoxycorticosterone acetate is probably also of value in overcoming shock. Respiratory instead of cardiac sequelae are noted.

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SUBMUCOUS LIPOMA OF THE COLON*

REPORT OF A CASE

JOSEPH T. GAULT, M.D., F.A.C.S. AND PHILIP KAPLAN, M.D.
Associate Attending Surgeon, Mt. Sinai Hospital Adjunct Surgeon, Mt. Sinai Hospital
CHICAGO, ILLINOIS

BENIGN tumors of the gastrointestinal tract are comparatively uncommon. Of these, submucous lipoma is the second most common tumor. Their infrequency in the colon and rectum can be judged by the fact that in 1937, Pembertom and McCormack,[11] in a comprehensive review, were able to collect only 116 cases. These tumors are interesting because their presence is rarely diagnosed preoperatively. Further, the great majority occur during the so-called cancer age—a fact contributing to the difficulty in diagnosis.

Three comprehensive reviews of lipoma of the gastrointestinal tract have appeared in the English literature. The earliest one is that of Stetten,[14] who, in 1909, reported seventy-seven cases. These included, two of his own cases and the rest from the literature. The next review is that of Comfort[4] who, in 1931, reported 181 cases of submucous lipoma of the gastrointestinal tract, including those of Stetten. The 181 cases included twenty-eight cases from the records of the Mayo Clinic and the remainder from the literature. Of the twenty-eight Mayo cases, three patients had been operated upon while twenty-five were cases in which submucous lipomas were found incidentally during 3,924 consecutive autopsies, an incidence of 0.6 per cent. Kirshbaum,[10] in a review of 5,724 autopsies at the Cook County Hospital, reported an incidence of 0.2 per cent, while Staemmler, in 17,000 necropsies, reported an incidence of 0.05 per cent of these tumors in the gastrointestinal tract. The most recent comprehensive clinical review is that of Pemberton and McCormack,[11] who limited their study of submucous lipoma of the colon and rectum. They collected 116 cases and included all of those previously reported at these sites. Ninety-seven of these were clinical cases while the remainder were found at autopsy. Thirteen additional clinical cases found in the literature since the publication of Pemberton and McCormack's paper are tabulated below. (Table 1.)

The clinical evaluation of these tumors to follow is based upon the three reviews mentioned above and fourteen additional cases since the publication of the last comprehensive review. These fourteen cases include our own.

Submucous lipomas are somewhat more frequently encountered in the large than in the small intestine. They are still less common in the stomach. Of the 181 cases reported by Comfort, ninety-two occurred in the large bowel, sixty-five in the small bowel and twenty-two in the stomach. In two cases, the data were insufficient for localization of the tumor. In the large bowel, the most frequent locations are the cecum, ascending colon, sigmoid flexure, transverse colon, rectum and descending colon in the order named. They are somewhat more commonly encountered in women and are most frequent in the fifth and sixth decades of life. The average age of the clinical cases as computed by Pemberton was 47.5 years. Of those cases seen at necropsy, the average age was sixty-three years.

Submucous lipoma of the large bowel, if small in size, may cause no symptoms whatsoever. This is testified to by the fact that they are found incidentally—although rarely—at autopsy. Eleven of the cases of

* From the Surgical Service of Dr. Victor L. Schrager, Mt. Sinai Hospital, Chicago, Illinois.

TABLE I

THIRTEEN ADDITIONAL CASES OF SUBMUCOUS LIPOMA OF COLON SINCE PUBLICATION OF PEMBERTON AND MCCORMACK'S REVIEW

	Weinstein Lieberman	Ross	Faber	Fetzer	Cabot	Kent Sawyer	d'Anella Tourec	Tizianello	Weise	Weise	Julian	Cooper	Anderson Fansler
Duration of symptoms		yrs.	12 yrs.	7 yrs.	2 yrs.	3 das.	2 das.	2 mos.	8 wks.	?	3 wks.	2 wks.	10–20 yrs.
Constipation	+			+	+				+	+	+		+
Blood							+		+	+	+		+
Anemia											Note: had previous resec. (7 yrs.) for ca. of desc. colon		
Loss of weight													
Palpable tumor mass	Pedunculated	L. epig.	R. pelvis	R. epig.	L. epig.	None	R. hypoch.	Epig.	L.L.Q.	L.L.Q.	?		
X-ray diagnosis			Pericecal granuloma	Ca. (filling defect) hep. flex.	Benign tumor cecum	No exam.	No exam.	Ovoid mass trans. colon	Sten. tumor splenic flex. ca. ca. ?	Sten. tumor splenic flex. ca. ?	Smooth filling defect trans. colon	No exam.	No exam.
Location of tumor	Rectum	Cecum	Cecum	Asc. colon	Cecum	All of colon. Multiple	Asc. colon hep. flex.	Trans. colon	Desc. colon at splenic flex.	Desc. colon at splenic flex.	Trans. colon	Cecum	Rectum
Evidence of intuss		+	+		+		+					+	
Surgical treatment	Removal with cautery	Cecotomy	Resection	Resection	Resection	Resection died	Cecotomy	?	Resec.	Shelled out	Resec.	Mikulicz	Excision

submucous lipoma of the gastrointestinal tract found at necropsy at the Mayo Clinic were situated in the colon and rectum. Of

Fig. 1. Roentgenogram of colon following barium enema showing filling defect in midportion of transverse colon.

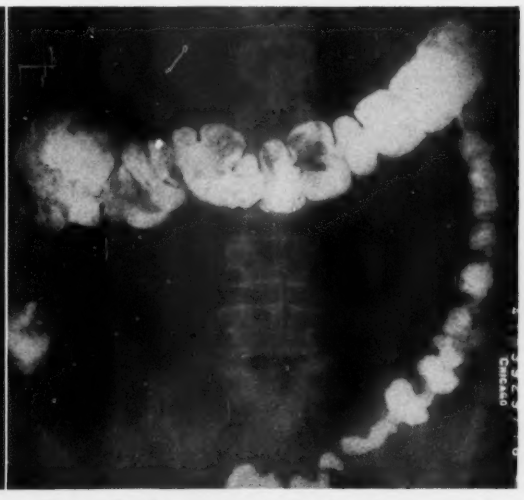

Fig. 2. Roentgenogram of colon three months after resection of tumor.

Kirshbaum's nine cases in 5,754 necropsies, two were in the colon. In none of these thirteen cases was there any record of symptoms referable to this tumor. The symptoms that are caused by these tumors may be ascribed to the pathologic changes that they undergo. A study of the clinical cases, that is, those patients operated upon, reveals that these tumors undergo three types of pathologic changes: First, because of growth, they cause obstruction by gradually encroaching upon the lumen of the bowel and interfering with the fecal current. This phenomenon is present in the great majority of the clinical cases. In the second group, comprising about one-third of the clinical cases, the tumor is associated with intussusception. As Stetten stated in his review of 1909, the tumor is usually at the apex of the invagination and probably interferes with peristalsis. It may be added, we believe, that the fecal flow may also serve to favor this phenomenon by propelling the tumor distalward. A rather noteworthy example of this phenomenon is reported from the Massachusetts General Hospital.[3] In this report, there is a description of the vizualization under fluoroscopy of the disinvagination of the cecum and a portion of the ascending colon which had become intussuscepted into the left side of the transverse colon. The barium enema passed freely to the left side of the transverse colon where it stopped in front of a rounded mass apparently occluding the lumen at that point. As the pressure of the barium solution was increased, the mass gave way and moved along the transverse colon, hepatic flexure and down to the midportion of the ascending colon. After evacuation, the mass returned to its original position in the transverse colon. This phenomenon was noted three times during the period of observation, twice with the use of a barium enema and once with insufflation of air. At operation, a polypoid pedunculated lipoma was found arising in the cecum 8 cm. distal to the ileocecal valve.

The third pathologic change characteristic of this tumor is erosion of its dome resulting in slow hemorrhage. This was present in about one-fourth of the cases reported by Pemberton. It was also present in our own case. In view of the fact that these tumors are usually attached to the wall of the bowel by a pedicle and, so to speak, float freely in its lumen, a fourth complication—strangulation of the tumor with resulting gangrene—would seem to be possible. However, probably because of the fact that the pedicle of these tumors oc-

curring in the colon is a broad one in the majority of cases, this phenomenon has not been reported. Any combination of the ception. This phenomenon was noted either at operation or during *x*-ray studies in three of the six clinical cases reported from the

FIG. 3. Photograph of gross specimen.

three pathologic changes may co-exist in varying degrees. The combination most frequently encountered is that of obstruction with slow hemorrhage.

Clinically, the symptoms may be classified into two groups: In the first group, there is a long history of gradually increasing constipation with recurring attacks of pain in the abdomen often with nausea and vomiting, following particularly the intake of bulky or heavy foods. These attacks occur usually months or years apart, last several days and are often terminated by bloody, diarrheic stools. Between these attacks, the patient is comparatively comfortable except for the increasing constipation. The attacks may occur over many years—twelve years in Faber's[6] case in which a submucous lipoma of the cecum was found at operation. The average duration of symptoms as computed by Pemberton and McCormack in their reported cases was 41.5 months. The long duration of these symptoms, unaccompanied as they are by loss in weight, anemia or cachexia is characteristic of submucous lipoma of the colon.

In the second group of cases, the clinical picture is more acute—that of bowel obstruction in varying intensity. Into this group fall most of the cases of intussus-

Mayo Clinic[11] and in four of the thirteen recently reported cases tabulated in Table 1. The symptoms in these acute cases are of a few days' or a few weeks' duration. Because of the great similarity between the clinical entity produced by an acutely obstructing lipoma and that so often produced by carcinoma, a diagnosis of benign tumor is rarely made. It is to be remembered that many of the chronic cases terminate with or come to surgery because of symptoms of acute bowel obstruction or severe pain.

X-ray studies of the colon are usually not very helpful in establishing a diagnosis of benign tumor. Most often, "carcinoma," "obstructive lesion" or "filling defect" is the report. This is of course understandable on the basis that lipoma, particularly when attached to a broad pedicle, will give rise to a filling defect suggestive of carcinoma. It is to be noted that in the six cases seen at the Mayo Clinic up to 1935,[11] a diagnosis of carcinoma was made in two cases, polypoid mass with a tendency to intussusception in one case, multilobular mass in the colon with a tendency to intussusception in another case and polypoid tumor in the remaining two cases. Of the thirteen tabulated cases, a diagnosis of carcinoma was made in three cases, that of benign tumor

with a suggestion that it may be a submucous lipoma in one case[3] and diagnoses similar to those mentioned above in the remaining nine cases.

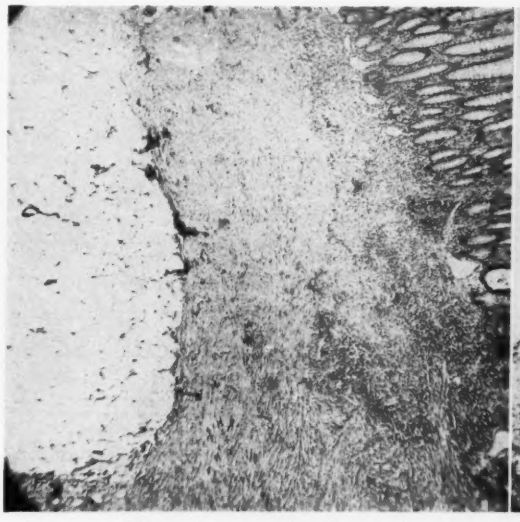

Fig. 4. Photomicrograph of nonulcerated portion of tumor. Note thickening of submucosa.

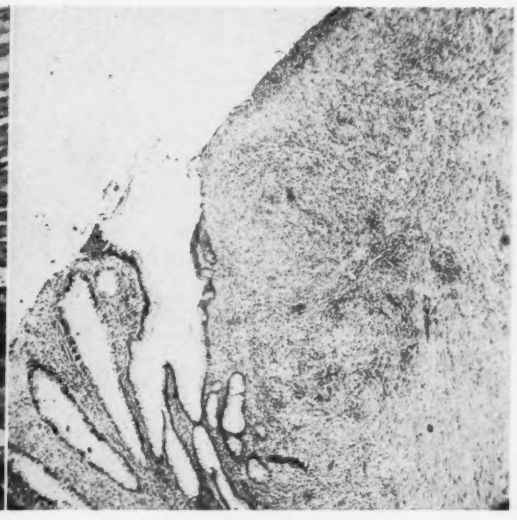

Fig. 5. Photomicrograph of portion of dome of tumor showing ulceration of the mucosa and the membrane covering the lipoma over the ulcerated area. Membrane consists of leucocytic and fibrinous exudate with areas of granulation tissue containing giant fibroblasts.

The surgical treatment of submucous lipoma depends upon the extent of the involvement of the bowel wall. In most of the reported cases, either resection in one or more stages or an exteriorization procedure was followed out. In a few cases, colotomy with primary repair of the bowel was performed.[2,12,17]

CASE REPORT

Mrs. R. H., age forty-four, was admitted to the Mt. Sinai Hospital on September 30, 1938 with the history that for six months prior to admission she had experienced attacks of low abdominal pain lasting two to three days, associated with five to ten bloody, diarrheic stools daily. She stated that during this period of six months she would often have a sense of fullness in the epigastrium, particularly after eating raw vegetables, fruits or heavy meats. These attacks occurred every two to three weeks. Between attacks, there was moderate constipation. She had had no symptoms referable to the gastrointestinal tract prior to the onset of these episodes. There was no loss in weight prior to or during this six months period There was a history of hypertension for eight years. Her blood pressure had ranged between 164/90 and 230/115. There was nothing of further significance in the clinical history.

On physical examination, the only noteworthy finding was a blood pressure of 210/95. The resident physician stated that he believed a mass was present in the upper abdomen. However, this finding was not corroborated by the attending physicians. Urine analysis revealed a faint trace of albumen. The benzidine test for blood in the stool was two to three plus positive on several examinations. The hemoglobin was 85 per cent, red blood cell count 4,260,000, white blood cell count 8,550 with the cells in normal ratio. The Wassermann and Kahn tests were negative.

Barium was administered by mouth. The small bowel and colon filled well up to a point a little to the left of the middle of the transverse colon where an obstruction was noted. The ascending and right half of the transverse colon were dilated. It was noted that the edges of the defect were well defined, but there was marked destruction of the mucosa on special films. The mass in the transverse colon was estimated to be the size of an apple. The roentgenologic diagnosis was carcinoma of the colon. (Fig. 1.)

At operation, (V. L. Schrager) an intrinsic tumor mass of the transverse colon about two to three inches to the left of the midline was

found. The transverse colon was opened and attached to its posterior wall there was found a roundish, gray-yellowish mass about the size

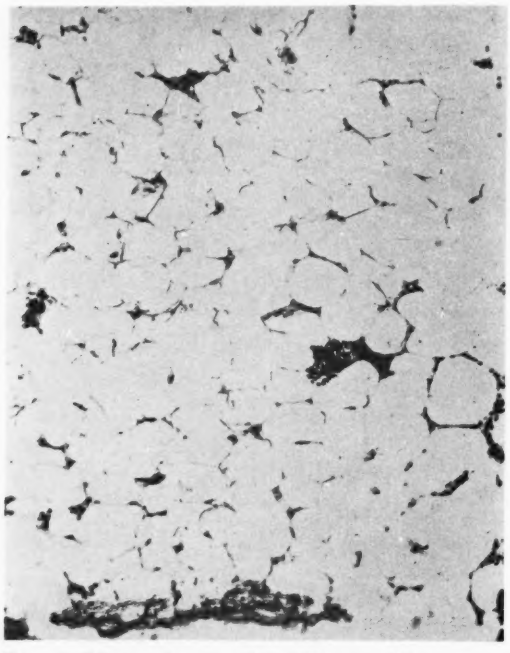

FIG. 6. Photomicrograph of lipoma. Note accumulation of lymphocytes and polyganal cells.

of a lemon which seemed to obstruct the lumen almost completely. The mass was attached to the bowel by a broad pedicle. A diagnosis of submucous lipoma was made. The bowel wall on either side of the mass appeared normal. About five inches of the colon including the mass was resected. The continuity of the bowel was re-established by an end-to-end anastomosis.

A Levine tube was placed into the duodenum on the first postoperative day and removed on the fourth day. Convalescence was uneventful except for a slight induration of the wound on the sixth day which cleared up rapidly with applications of heat.

In the gross examination of the specimen, Dr. Davidson, pathologist, noted that the lipoma, which measured 44 mm. in height, 50 mm. in length and 35 mm. in width, originated from the wall of the colon corresponding to its mesenteric attachment. (Fig. 3.) The tumor obstructed the lumen almost completely. Near its base, there was a papillary outgrowth 10 mm. in length. On section, the tumor was found to consist of fatty tissue enclosed by the mucosa. (Figs. 4 and 6.) Histologic examination revealed absence of mucosa in the dome of the tumor where there was replacement by granulation tissue containing many giant fibroblasts. (Fig. 5.)

An *x*-ray study of the colon four months after the resection, January 25, 1939, revealed some narrowing in the region of the anastomosis. Three months later the transverse colon appeared perfectly normal. (Fig. 2.) The patient has had no recurring symptoms to date.

SUMMARY

1. Submucous lipoma of the large bowel is comparatively rare.

2. Because of its occurrence during the so-called cancer age, the similarity of the symptoms, particularly when acute, to those of obstruction due to carcinoma, and the absence of a characteristic defect on *x*-ray studies, submucous lipoma of the colon is rarely diagnosed preoperatively. In cases of suspected pathologic conditions of the colon presenting a long history of recurring attacks of pain, constipation, bloody diarrhea, unassociated with loss in weight or with cachexia, a benign lesion of the colon should be suspected.

3. Intussusception is a rather characteristic complication of submucous lipoma of the colon.

4. Thirteen cases of submucous lipoma of the colon and rectum found in the literature since the publication of Pemberton and McCormack's review in 1937 are tabulated.

5. A case report of submucous lipoma of the transverse colon is presented.

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Sterility of the operative field is impossible to obtain in surgery of the rectum and anus except in a few operations which are performed through a perianal skin incision without entering the bowel lumen.
From—"The Rectum and Colon"—by Hayden (Lea & Febiger).

METASTATIC CARCINOMA IN THE UTERUS*

HERMAN CHARACHE, M.D.
BROOKLYN, NEW YORK

METASTATIC carcinoma in the uterus is very rare. According to Virchow[1] those organs which are frequently the seat of primary tumors are seldom affected by metastatic growths; and according to Ewing[2] the uterus is the first on the list of organs affected by primary cancer.

The subject of metastatic tumors in the uterus is hardly mentioned at all in the literature, except in some instances when discussing carcinoma of the ovary and its relationship to carcinoma of the uterus. Because of the close proximity of the two organs and the intimate relationship of their lymphatics, it is often difficult to determine which of the two is the primary seat of the cancer. This is particularly true when the malignancy is limited to the pelvic organs.

Offutt,[3] in 1932, reported 616 cases of papillary cyst adenocarcinoma of the ovary from the Mayo Clinic. Eight and six-tenths per cent of the cases were associated with carcinoma of the uterus; and in 521 cases of adenocarcinoma of the body of the uterus, there was associated carcinoma of the ovary in 11.9 per cent. Norris and Murphy[4] in the same year reported ninety-three cases of malignant ovarian neoplasms, 11.8 per cent of which also involved the uterus.

Metastasis usually takes place by the lymphatic route and by contact implantation. Transtubal dissemination has been reported by Sampson,[5] Clark and Norris,[6] and Offutt. In several of Offutt's cases, carcinomatous cells were found in the lumen of the Fallopian tubes, while the blood vessels and lymphatic channels of the tubes were apparently normal. Two similar cases were found by Clark and Norris. The latter believe that transtubal dissemination occurs in many cases of combined ovarian and uterine carcinoma. Ruge[7] has demonstrated that 12 to 13 per cent of carcinoma of the Fallopian tubes metastasizes to the uterus.

Sampson advocates the ligation of the fimbriated end of the tubes before proceeding with the removal of the cancerous tissue, and the limitation of uterine curettage for fear that some of the curettings may make their way to the peritoneal cavity. One other suggestion may be added —the abolition of the uterine retractors which, when clamped forcibly down on the uterus, squeeze its contents through the Fallopian tubes into the peritoneal cavity.

Novak[8] strongly supports the theory of lymphatic extension in cases of combined ovarian and uterine malignancy, and he questions the extension of the malignancy by contact implantation, although not denying its existence.

Metastatic carcinoma in the uterus from extrapelvic organs is extremely rare. Only fifty-six cases have been reported in the literature up to the present writing.

Thirty-one cases had their origin in the breast (55.4 per cent). Seventeen of them were reported by Töröck and Wittelshöfer[9] from the Vienna Pathological Institute covering a period of sixty-two years (1817–1879). The others were single case reports. Two of the cases, reported by Franqué[10] and Schaper,[11] occurred in pregnant women. The former gives a very good discussion on metastatic carcinoma of the uterus.

Fourteen cases had their origin in the stomach (25 per cent). One of these cases, reported by Senge,[12] metastasized to the placenta.

* From the Brooklyn Cancer Institute, Brooklyn, New York.

Nine cases originated in the following organs: lungs three, pleura one, pancreas one, liver one, gallbladder one and kidney two. Two metastasized from melanocarcinoma. All cases came to autopsy.

Four additional cases of metastatic carcinoma in the uterus are here reported. Three originated in the breast, making a total of thirty-four cases of metastatic carcinoma of the uterus originating in the breast up to the present writing. The fourth case had its origin in papillary adenocarcinoma of the ovary.

CASE REPORTS

Case I. *Metastatic Carcinoma in the Uterus, Primary in the Ovary.* A. K., a white female, aged forty-eight, was admitted to the Brooklyn Cancer Institute on November 3, 1939, for *x*-ray therapy, following a supracervical hysterectomy and bilateral salpingo-oophorectomy in another hospital. The operative diagnosis was papillary adenocarcinoma of the right ovary with metastasis to the uterus. This was confirmed by histological study.

The preoperative history consisted of abdominal pain and distention of five months' duration, irregular menses of two to three years, associated with passing of clots and excessive vaginal bleeding lasting from twelve to eighteen days. She was married and had two children. Her past history and family history were not relevant.

On admission to our institution the patient appeared well nourished but somewhat dyspneic. The abdomen was markedly distended with fluid. A palpable, freely movable tumor, the size of an orange, was found in the right upper quadrant. Pelvic examination revealed the stump of the cervix fixed by a palpable tumor in the posterior cul-de-sac and a nodular indurated parametrium. Following the removal of 1,100 cc. of straw-colored fluid by abdominal paracentesis, numerous nodules were felt throughout the abdomen. The rest of the physical examination did not reveal any noteworthy pathology.

The urine showed the presence of two plus albumin and numerous white cells, with some hyalin casts. The blood urea was 20 mg., creatinin 1 mg., and sugar 60 mg. The blood Wassermann test was negative. The blood count showed 3,240,000 red blood cells with 56 per cent hemoglobin. The white count was 20,100 with 89 per cent polymorphonuclear leucocytes and 21 per cent lymphocytes. An intravenous pyelogram revealed no pathological condition of the kidneys. *X*-ray of the chest showed no pathological condition of the lungs or heart.

The patient remained in the hospital under supportive treatment with repeated abdominal paracentesis and *x*-ray therapy to the abdomen. She died on April 17, 1940. An autopsy was performed and reported by Dr. Herman Bolker as follows: (1) Papillary adenocarcinoma of ovary with metastasis to the uterus (status postsupracervical hysterectomy and bilateral oophorectomy) with (a) peritoneal metastases involving the surfaces of all abdominal viscera, with ascites, (b) peritoneal fibrosis, with multiple adhesions, (c) metastases to iliac lymph-nodes and retroperitoneal tissues, (d) cervical erosion, and (e) subacute urocystitis. (2) Right fibrous pleurisy, (3) chronic cholecystitis with cholelithiasis; and (4) aortic aterosclerosis.

Case II. *Metastatic Carcinoma in the Uterus, Primary in the Breast.* B. B., a white female, aged fifty-five, was admitted to the Brooklyn Cancer Institute on November 9, 1937, complaining of pain in a postoperative mastectomy scar and pain in the right hip radiating to the back.

In February, 1935, she noticed a small lump in her breast associated with pain in her right arm. She was admitted to a hospital where a diagnosis of carcinoma was made. The diagnosis was confirmed histologically following a radical mastectomy. The patient later received postoperative deep *x*-ray therapy.

Two years later, May, 1937, she developed a mass in the right axilla associated with pain and difficulty in manipulating her right arm. The tumor disappeared four months later following the insertion of twelve radon seeds by a private physician. Two months later she was admitted to our Institution.

She had never had any other illness. Her menopause was three years previous to admission. Her family history was irrelevant.

Physical examination revealed a well developed, well nourished white female, not acutely ill. A firm fixed gland, measuring 2 cm. in diameter, was found in the right supraclavicular region. The right breast was absent. There was no evidence of any recurrence. En cuirasse nodules were present in the chest wall. The left

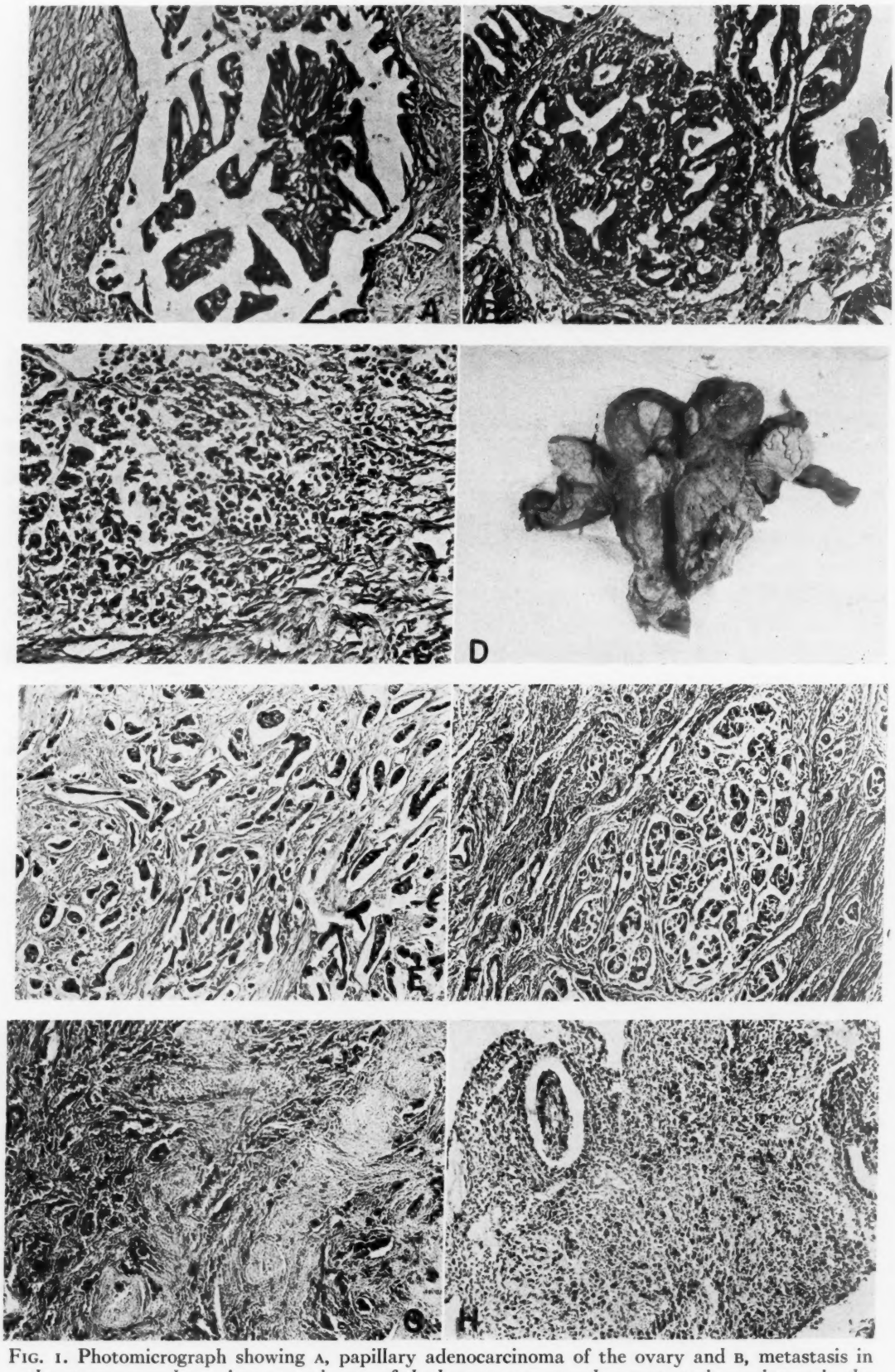

FIG. 1. Photomicrograph showing A, papillary adenocarcinoma of the ovary and B, metastasis in the uterus; E and G, primary carcinoma of the breast; C, D, F and H, metastatic carcinoma in the uterus. 180 ×.

breast was free from tumefaction. A moderate amount of induration was found in the right axilla. Her heart and lungs did not reveal any evidence of pathological conditions. The abdomen was free from any palpable tumor. Pelvic examination revealed a partially stenosed introitus and an enlarged uterus diagnosed as a fibroid. The blood Wassermann test was negative. The blood count, blood chemistry and urine examination were within normal limits. Roentgenographic study of the lungs and skeleton revealed a metastatic lesion and partial destruction of the second lumbar vertebra with no other evidence of metastatic involvement.

The patient received deep *x*-ray therapy to the right supraclavicular area and lumbar spine, resulting in relief of her symptoms. She was followed up in our clinic.

Three months later she was readmitted to the hospital complaining of vaginal bleeding, recurrent back pain and inability to move her bowels for ten days. She stated that her rectum was closed and was unable to admit the enema tube.

At this time the patient appeared jaundiced. The nodule in the right supraclavicular region was twice its former size. The lower portion of her abdomen was distended. A metastatic nodule measuring 3 cm. in diameter was palpable near the umbilicus. She had a large indurated mass in the posterior vaginal wall pressing on the rectum. The rectal opening was very small and constricted. Roentgenographic examination at this time revealed metastatic involvement of the right femur in addition to the destruction of the second lumbar vertebra present at her previous admission.

The patient was kept comfortable under supportive treatment. She died March 8, 1939, Autopsy performed by Dr. Bolker was reported as follows: (1) Carcinoma of the right breast (postoperative radical mastectomy) with metastasis to the substernal, tracheobronchial and retroperitoneal lymphnodes, lungs, liver, peritoneum, spleen, uterus, ovaries, vagina, rectum, second lumbar vertebra; and (2) acute purulent pneumonia.

Case III. *Metastatic Carcinoma in the Uterus. Primary in the Breast.* P. D., a white female, aged forty-eight, was admitted to the Brooklyn Cancer Institute on January 13, 1940, complaining of pain and swelling of her left arm and neck, backache, pain in the left hip and knee.

In March, 1936, she had a radical left mastectomy in another hospital. She received preoperative radium treatment and postoperative *x*-ray and radium therapy. She returned to the same hospital three years later with metastatic involvement of the dorsal spine and was treated with alcohol block, cobra venom, and large doses of morphine for intractable pain. She was later referred to the Brooklyn Cancer Institute for supportive treatment.

Examination revealed a white adult female, chronically ill, poorly nourished, confined to bed. The left pupil was smaller than the right, with a drooping of the upper lid, showing evidence of Horner's syndrome. The cervical glands were bilaterally enlarged, extending from the supraclavicular area to the occiput. The skin of the neck showed marked radiation changes with pigmentation. Similar radiation changes were found over the chest and upper portion of the abdomen. Numerous en cuirasse nodules were present over the chest wall. The right breast was firm and solid. The nipple was retracted and the skin was covered with en cuirasse nodules. The left upper extremity was more than twice the normal size. The lymphedema included the fingers, which were contracted and deformed.

The skin of the left upper portion of the abdomen was edematous and nodular. The liver was enlarged to two to three fingers below the costal margin. Both gluteal regions were lymphedematous. The entire course of the spine was very tender on palpation.

The blood count showed 3,860,000 red cells with 73 per cent hemoglobin and 10,450 white cells with 66 per cent polymorphonuclear leucocytes, 27 per cent lymphocytes and 7 per cent monocytes. The blood chemistry was within normal limits. The blood Wassermann test was negative. Roentgenographic examination revealed widespread metastasis of the fourth, fifth, sixth, seventh, eighth and twelfth thoracic, first, second and third lumbar vertebrae, sacrum and pelvis.

The patient was kept comfortable with supportive treatment until April 9, 1940, when she expired. An autopsy was performed and reported by Dr. Bolker as follows: (1) Carcinoma of left breast with (a) metastases to skin of chest wall, tissues of neck, left pleura with effusion and pulmonary atelectasis, hepatic portal lymphnodes with dilatation of right hepatic bile duct, omental nodes, vermiform appendix, left ureter with mild hydronephrosis,

urinary bladder, uterine wall (fundal and cervical), left Fallopian tube and round ligament, gastric and rectal serosae; (b) edema of left upper extremity; (c) radiation changes, skin of chest; (d) status post right radical mastectomy. (2) Acute purulent bronchopneumonia; (3) cavernous hemangioma of liver; (4) adrenal medullary calcification; (5) myoma uteri; and (6) aterosclerosis.

Case IV. *Metastatic Carcinoma in the Uterus, Primary in the Breast.* F. C., a white female, aged forty-seven, was admitted to the Brooklyn Cancer Institute on February 1, 1940, complaining of a lump in a postoperative mastectomy scar. In June, 1936, she had a radical mastectomy in another hospital. The pathological report was duct cell carcinoma, alveolar in origin. The diagnosis was confirmed in our Institution. Following operation she was in excellent health for three and one-half years. Three months previous to admission to our Institution, she noticed a lump in the postoperative scar. This was associated with some loss of weight and general weakness.

Her menstrual periods began at the age of eleven, were always regular, lasting for four days. For the last six months she had marked dysmenorrhea and profuse menorrhagia, which left her in a very weak, rundown condition. Her past history and family history were uneventful.

Examination revealed an adult white female, somewhat anemic in appearance, moderately well nourished. Several pea-sized nodules were present over the mastectomy scar. The surrounding skin was contracted and firmly adherent to the chest wall. Similar nodules were present over the manubrium sterni and epigastric region. The right arm was lymphedematous, as was the left breast, but there was no palpable tumor present within the breast. The supraclavicular and axillary glands were not enlarged.

Pelvic examination revealed the cervix to be larger than normal and cystic. The fundus was firm and enlarged to the size of an eight months' gestation. The uterus was freely movable in all directions. The adnexa were free from any tumefaction. The rest of the physical examination did not reveal any evidence of a pathological condition.

The urine was not pathologic; the blood chemistry was within normal limits; the blood Wassermann test was negative. The blood count showed evidence of a low grade anemia, but was otherwise normal. Roentgenogram of the chest and pelvis showed no evidence of pulmonary or osseous metastasis.

A biopsy from one of the chest nodules was reported as metastatic in origin. The curettings from the cervix and fundus were also found to be metastatic carcinoma of mammary origin. The pathological report by Dr. Bolker was as follows: Microscopic examination: The endometrium consists of numerous tortuous glands in the secretory phase. There is some swelling of the stromal cells. In spotty areas there is an invasion of groups of atypical cells which occur in rows or small alveoli. They occasionally surround the uterine gland without causing its destruction. The individual cells are polygonal in outline, with a deep pink cytoplasm, and vesicular or markedly hyperchromatic irregular nuclei. One area shows an invasion of the uterine musculature. There is a heavy localized infiltrate of lymphocytes and polymorphonuclear leukocytes. The cervix is lined by intact histologically normal layer of stratified squamous epithelium. Deep in the stroma paravascular are small groups of atypical cells which strongly resemble those of the uterine lesion. They are surrounded by fibrous tissue, the bundles of which are collapsed. Diagnosis: Metastatic carcinoma of uterus, fundal and cervical.

The patient received 1,500 mg. of radium into the uterus and a similar amount in the form of radium needles to the nodules of the skin.

On June 4, 1940, an exploratory laparotomy was performed. Multiple greyish, white nodules were found covering the peritoneal surface of the uterus, tubes, the serosa of the small intestine (ileum) and the peritoneum of the lower abdominal wall. The para-aortic glands were enlarged. The liver was not involved. Several of the nodules were removed for histological study and were reported as metastatic carcinoma of breast origin.

The patient is now convalescing in the hospital and receiving radiation therapy to the pelvis.

SUMMARY AND CONCLUSION

1. Metastatic carcinoma in the uterus is very rare. When it does occur, the primary lesions, in order of frequency, are: ovary, Fallopian tubes, breast and stomach. Cases

with primary lesions in the lungs, pleura, pancreas, liver, gallbladder and kidney, as well as two melanocarcinomas, are reported.

2. Still rarer are metastatic tumors in the uterus of extrapelvic origin.

3. Only fifty-six such cases were reported in the literature.

4. Four additional proven cases of metastatic carcinoma in the uterus are here reported from the Brooklyn Cancer Institute. Three had their origin in the breast and one in the ovary.

5. Of the fifty-nine cases of metastatic tumor in the uterus of extrapelvic origin, thirty-four or 57.6 per cent had their origin in the breast.

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DEEP CAVERNOUS HEMANGIOMA OF THE NECK

CASE REPORT

EDMUND G. LAIRD, M.D.
WILMINGTON, DELAWARE

RECENT experience with a case of nonpulsating, cavernous hemangioma in the neck caused me to review the literature dealing with this type of tumor in an attempt to clarify practical points in the differential diagnosis of tumors of the neck. It is my belief that these angiomas are not rare in occurrence and that dissemination of the knowledge of the cardinal signs of this lesion will result in a higher percentage of permanent cures. This case report describes this type of angioma as subcutaneous without involvement of the overlying skin, erectile, without bruit or pulsation.

Investigation of the literature shows that there is lack of agreement regarding the nature, the classification and the nomenclature of angiomas. MacCallum[1] believes them to be neoplasms, stating, "A true hemangioma is distinguished from a mere dilatation of capillaries or venules belonging to the general circulation by the fact that its blood channels grow independently without regard to the laws which govern the distribution of such vessels." He emphasizes the fact stated by Ribbert[2] that injections of solutions or substances into these tumors spill over very slightly, if at all, into the blood stream. Aschoff[3] likewise considers them as new growths whose vessels develop from mesenchymal syncytium and have a luxurious connective tissue foundation. He believes true angiomas to be congenital and refers to the cirsoid aneurysms and other abnormal arteriovenous communications as altered, hypertrophied and expanded blood vessels of normal derivation. Kaufman[4] classifies hemangiomas as simplex or hyperplasticum, depending on whether the dilatation of the vessels or the formation of new vessels predominates.

Reid's[5] comprehensive study of this subject inclines him to the belief that both angiomas and cirsoid aneurysms are caused by a traumatic or congenital pathological condition and he looks upon both as abnormal arteriovenous communications rather than as neoplasms. The following is quoted from Reid: "The histogenesis of simple angiomas is not definitely agreed on. Most all authors of textbooks on pathology mention the controversy that has existed for a long time over the advisability of calling angiomas true tumors. Everyone agrees that the vascular endothelium may give rise to tumors possessing the properties of independent growth and even of metastasis. Examples of such growths are the hemangio-endotheliomas, pigmented nevi, and the hemangioma simplex described by Borrman. Yet the great majority of so-called angiomas are composed simply of swollen blood vessels and do not exhibit the qualities of independent growth characteristic of true neoplasms. For this class of angiomas Albrecht, who considered them to be due to developmental defects, suggested the term of hemartoma. A strong opponent of the neoplastic nature of angiomas is Adami. Thoma considered mechanical factors a very important influence in the growth of angiomas. Others (Rokitansky and Borst) regarded many of them as simple hypertrophy of vascular segments without neoplastic growth. Unna, perhaps noting the frequency of simple angiomas in certain locations of the body, suggested that they were due to abnormal pressure exerted during fetal life. Others (Ewing, MacCallum, Aschoff, etc.) while stating the controversy over the histogenesis of angiomas, are inclined to treat them as neoplasms or partial neoplasms arising from a displaced segment of the

vascular bed which comes to possess a limited power of an aberrant growth. Although my researches do not yet furnish definite proof of the etiology of simple agiomas, I cannot escape from the conclusion that they are dilatations of the small arteries and veins caused by a traumatic or congenital abnormal communication between the smallest arteries and veins. They are, I believe, arterio-venous communications (without the medium of capillaries) between the arterioles and venules."

In agreement with Reid's belief Homans[6] states that: "Basically all such as are not of traumatic origin belong to one family: that is they are failures of development in the common capillary plexus of the embryo from which the arteries and veins are evolved. All are apt to be called angiomas, or hemangiomas, with the implication that they grow." The essential difference between hemangiomas and cirsoid aneurysms seemed to him to be merely a matter of the size of the vessels between which the communication occurs. Homans emphasizes the supply of arterial blood without pulsation in both the capillary and the cavernous angiomas.

Rankin and Chumley[7] have chosen the following simple classification with which most authors agree: (1) Angioma simplex (capillary angioma); (2) angioma cavernosum (cavernous angioma); and (3) angioma simplex hypertrophicum (angio-endothelioma).

In the third group fall the lesions resembling true neoplasms. Borderline lesions varying from simple angioma with proliferating endothelium to true angio-endothelioma are difficult to classify as are also the invading and metastasizing tumors of vascular endothelial origin. Such cases have been reported by Borrman,[8] Schmitt,[9] and Ernst.[10] Arteriovenous fistulae or aneurysms may be considered as a variation of classes 1 or 2, or as a separate clinical entity. I prefer to classify them apart from the true angiomas.

CASE REPORT

E. F., a six year old girl, was admitted to the Wilmington General Hospital May 26, 1939. While recuperating from pneumonia four years previously, she developed a marble-sized mass in the left side of the neck. It was not tender and it never discharged externally. This mass gradually increased to about the size of a hen's egg in the four-year period. Every month or so the child developed fever, sweats, anorexia and slight dysphagia. On these occasions the mass enlarged to three times its normal size. There were no choking sensations, aphonia or stridor. The diagnosis on admission was branchiogenic cyst. Family history and past history revealed nothing significant.

Physical examination revealed the temperature to be 99.2 degrees, pulse 100, respiration 22. The patient was a moderately well nourished child of six years, quite comfortable in a supine position. There was no cyanosis or dyspnea. The pupils were equal and reacted normally. The head was unremarkable. No respiratory stridor, dysphagia or dysphonia was demonstrable. In the left anterior cervical triangle was a round, smooth swelling, the size of a hen's egg, extending from the anterior median line of the neck to the anterior border of the sternomastoid muscle and from the level of the hyoid bone to a little below the cricoid cartilage. (Fig. 1.) It moved with deglutition and firm steady pressure caused it to disappear partially only to reappear rapidly upon release. No bruit or murmur could be heard. It did not transilluminate and, when compressed, small pea-sized nodules could be felt along its medial portion. Hard, enlarged, nontender lymphnodes were palpable in the right posterior cervical triangle and at the angle of the mandible on the right. The mass was not attached to the skin and there was no discoloration of the overlying skin. Cutaneous temperature was normal over the tumor. The heart, lungs and abdomen showed no abnormalities. The rate and rhythm of the pulse were normal.

Hemoglobin was 88 per cent, erythrocytes 5,000,000, leukocytes 6,000, differential blood count; neutrophiles 63 per cent, lymphocytes 35 per cent, young neutrophiles 1 per cent, eosinphiles 1 per cent. Urinalysis was negative. Blood Wassermann test was negative. Throat

culture showed growth of pneumococci and staphylococci.

X-rays showed swelling in the soft tissue of the left side of the neck and calcification just below the hyoid line on the left. Aspiration of the mass yielded unmixed blood. This procedure caused the tumor to shrink in size only to refill rapidly.

Five days after admission, operation was performed. A tortuous, cirsoid mass of dilated blood vessels was exposed. A distinct capsule which was readily differentiated from the surrounding structures was dissected out. Posteriorly this was firmly adherent to the hyoid bone and laterally it blended inseparably with fibrous tissue in the region of the carotid sheath.

FIG. 1. Hemangioma of the neck before operation; taken May 30, 1939.

FIG. 2. Same patient after operation; taken July 19, 1939.

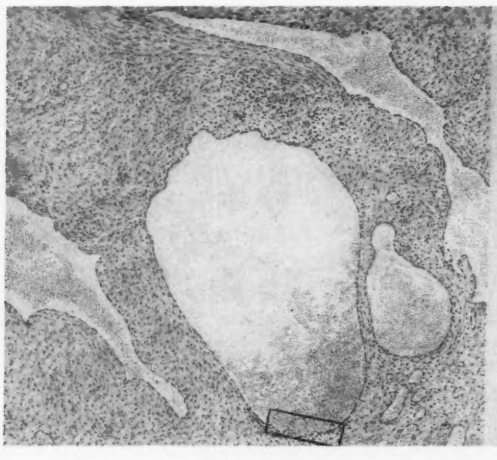

FIG. 3.

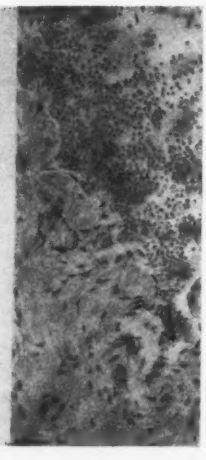

FIG. 4.

FIG. 3. Microscopic section of the tumor showing blood spaces, both distended and collapsed, in a dense connective tissue stroma. × 50.

FIG. 4. Same as Figure 3. Showing blood space line with a single layer of endothelial cells. × 225.

It received an abundant supply of blood from this region although the individual vascular channels could not be identified. Within the dilated veins were several calcified phleboliths.

DISCUSSION

The evidence of an associated inflammatory process in conjunction with the lesion in the case herein reported lends support to the contention of Billroth[11] that angiomas or cirsoid aneurysms are caused by inflammatory changes in blood vessels. Carnett[12] in his report of two cases commented on this association and also on the presence of calculi in this type of angioma. In the case herein reported the history suggests repeated inflammatory episodes. These lesions have been known to undergo thrombosis and ultimately to disappear following infection. Important points in the differential diagnosis include the compressibility of the swelling, its increase in size on straining or coughing (a phenomenon not present in the case reported), the presence of a bruit or thrill, the aspiration of blood

TABLE I

DEEP CAVERNOUS HEMANGIOMAS OF THE NECK REPORTED IN THE LITERATURE

No.	Author	Patient's Age	Sex	Treatment	End Result
1	Carnett, J. B.	20 yrs.	F.	Surgical excision	Cured
2	Carnett, J. B.	28 yrs.	M.	Surgical excision	Cured
3	Lincoln, R. P.	33 yrs.	M.	Electrical coagulation ("electrolysis")	Cured
4	Lediard, H. H.	6 mos.	?	Surgical excision	Cured
5	Rankin, F. W. Chumley, C. L.	38 yrs.	M.	Surgical excision	Cured
6	Eliot	35 yrs.	M.	1. Surgical excision 2. Surgical excision	1. Recurred 2. Cured
7	Sutter, H.	?	?	?	?
8	Giraldes	?	M.	Injection with bichloride of iron	Cured
9	Volkman (Eisenreiter)	4 yrs.	F.	Surgical mass ligation in stages	Death
10(?)	Kronlein (Eisenreiter)	12 yrs.	M.	Surgical excision	Cured
11(?)	Israel (Eisenreiter)	16 yrs.	M.	Surgical excision	Cured
12	Kuster (Eisenreiter)	10 yrs .	M.	Attempted surgical excision	?
13	Eisenreiter	19 wks.	F.	Ligation with silver wire	Death

The mass was excised and a small rubber tissue drain was inserted.

The postoperative course was not remarkable except that there was a low grade inflammatory reaction with induration about the wound. The temperature rose to 101 degrees on the first two postoperative days.

Microscopic examination showed striated muscle with perivascular infiltration of polymorphonuclear leukocytes. The connective tissue showed many dilated vessels. Several areas of calcification presented. Diagnosis: Cavernous hemangioma with calcification and inflammatory reaction.

On February 12, 1941, twenty-one months after operation, the scar was minimal and there was no recurrence of the swelling. No bruit could be heard over the area.

and the presence of calcification demonstrated by roentgenogram. The angiomas must be differentiated from aerocele (air cyst), hypertrophy of the thyroid gland with excessive vascularity ("windy goiter") and hernia of the lung.

Table 1 shows that surgical excision has been employed commonly as the method of treatment in thirteen cases of which authentic reports have been found. As there are reported cures by injection, this method is considered as acceptable particularly since the connection of these angiomas with the general circulation is indirect and restricted. Peyton and Leven[13] have reported on the treatment of angiomas by injection. There are reports of the successful employment of radium and *x*-ray in the eradication of these angiomas. The frequency of occurrence of deep cavernous angiomas in the cervical region was reported on by Eisenreiter who listed thirty-five in this region in a complete report on 1,098 angiomas. Gessler found only five cervical angiomas among 221 cases while Maas reported one out of seventy-two cases.

SUMMARY

1. A brief review of the literature regarding hemangiomas has been presented, together with the prevalent views concerning their true nature.

2. The personal case of a deep cavernous hemangioma of the cervical region, cured by operation, was given in detail.

3. The differential diagnosis and treatment were discussed briefly.

4. References to thirteen similar cases are offered.

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SUBUNGUAL MELANOMA

REPORT OF A CASE

RAYMOND C. SCANNELL, M.D.
CARROLL, IOWA

SUBUNGUAL melanoma shares with melanoma of the eye the most favorable prognosis of this highly fatal type of new growth.[1] However, the favorable prognosis depends upon prompt recognition and adequate treatment.

There is no tumor more available for detection and for appropriate treatment than subungual melanoma. The average patient with this condition will, nevertheless, undergo a period of meddlesome treatment which will materially mitigate against his recovery. The explanation for this fact is that the possible diagnosis is not considered by the physician in his first examination.

This study deals with (1) the incidence of the tumor, (2) its recognition, (3) its treatment and (4) a presentation of a case which, despite its fortuitously favorable progress, examples the difficulty of diagnosis and the pitfalls of therapeutic effort.

INCIDENCE

One is impressed in considering the incidence of tumors of this type with the confusion in nomenclature. Subungual melanoma is known also as melanoblastoma, melanoepithelioma and melanosarcoma of the nailbed,[2] onychial melanoma and malignant whitlow.[3] One finds also that the term melanoma is used variously to include such benign lesions as the pigmented nevus.[4] In addition, tumors of this group have been variously called melanoepithelioma and melanosarcoma dependent upon the predominent type of cell and the pathologist's opinion as to the origin.

While the rarity of the lesion has been indicated by such statistics as those of White[5] who found no cases in 485 patients with various nail diseases, by the statistics of Farrell[6] who found only 2.6 per cent subungual melanoma in 265 cases of melanotic tumors, and the statistics of Affleck[7] with approximately the same incidence of subungual melanoma in melanotic tumors, it was considered interesting to determine the incidence in our own vicinity. Therefore, 18,752 new hospital admissions were studied dating from 1927 until 1940. A total of five melanotic tumors of various types were included in the diagnoses and of these only one, the present case, was a subungual melanoma.

RECOGNITION

Melanomas of any type including subungual are uncommon in negroes. There does not seem to be any significant difference in the sex distribution, although it is slightly higher in males. It occurs much more frequently in older subjects; in one series[8] approximately one-third were between the ages of forty and forty-nine and over one-half were above fifty. The average ages in a number of series reviewed varied from 55.9 to 58.7. The extremes appeared to be twenty-three and eighty.

History of injury is fairly frequent (i.e., 16 of 28);[8] it is definitely higher than in other melanomatous tumors.

Gross Pathology. The nail bed has been compared to the hair follicle.[9] In addition to certain other similarities, the nail like the follicle, which in primitive animals is a tactile organ, has a rich nerve supply with many tactile nerve endings. These are involved in the genesis of subungual melanoma.

Following injury, if this has occurred, the lesion typically begins as a paronchyia. The lesion develops often as an ulcer, black and fungating, raising the nail and involving

the sulcus and matrix. The nail frequently becomes brittle and thick; it breaks or splits and becomes involved in the ulcerative and granulative process. A pathognomonic coal-black border is nearly always present along the involved edge of the nail. The tumor seems to be independent of the skin, growing from beneath and displacing the eponychium upward. With ulceration pigmented streaks may appear in the skin about the tumor. Dressings may be stained darkly from the exuded serum. Like melanotic urine, it becomes brown on standing. Pigment may be absent.

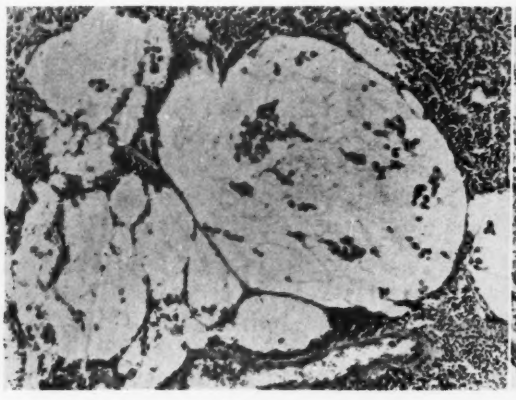

Fig. 1.

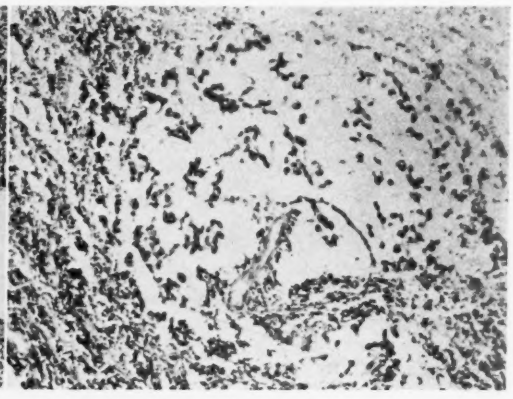

Fig. 2.

Figs. 1 and 2. There is a mucus-like degeneration of the tissue.

Growth is characteristically slow, spreading to the regional nodes in months; it may be rapid. The popliteal and cubital nodes are skipped usually; metastases in the inguinal and axillary regions may be sluggish in growth and extension. Inevitably rapid metastasis, probably by way of the blood stream, takes place to distant organs. The condition is then beyond treatment. Pain is never conspicuous.

Microscopic Pathology. This is varied and difficult. The tumor cells may be of any size or shape. Two types predominate: (1) spindle, which are deeper staining with fewer mitotic figures and more pigment, and (2) polygonal or spherical with a characteristic alveolar arrangement.[8]

Pigmented tumors may give rise to nonmelanotic metastasis and the reverse is said to be true.[3]

Newell comments on the extreme friability of the fixed tumor tissue. "This gives the finished frozen section a rather bedraggled appearance due to the falling apart of the tumor tissue when the section is thawed."

DIAGNOSIS

This is the critical point in the fate of the patient with subungual melanoma. The lesion occurs on a visible and prominent part of the body. It attracts attention early and it fails to respond to the casual treatment to which it may be subjected. The patient will, therefore, under ordinary circumstances, seek medical aid at a reasonably early stage in the condition while fair prospects of cure still obtain.

Any lesion about the nail in the middle aged, particularly if it is persistent, ulcerative and pigmented, should suggest subungual melanoma.

In the differential diagnosis Pack and Adair[9] have mentioned paronychia, pyogenic granuloma, onychomycosis nigrescens, subungual hematoma, primary syphilitic chancre of the finger, gangrene of the toe, Dupuytren's exostoses, subungual fibroma, subungual keratosis, subungual epithelioma, subungual angiosarcoma (Kaposi's disease), subungual tumors of the glomus and metastatic tumors of the nail bed.

Helpful in differentiation of subungual melanoma is the elicitation of a careful history, particularly regarding injury, possible

evidence of syphilis or diabetes, and the evolution of the local condition including the possibility of foreign body and the rate of growth. General physical examination including serology and urinalysis is of obvious importance. The appearance of the lesion, particularly regarding location and pigment content, rupture of the nail and the radiosensitiveness may be suggestive. *X*-ray examination, examination of the nail scrapings in potassium hydroxide solution or various culture media and biopsy are important, especially in some cases. The condition of other nails should be taken into consideration since the fairly common onychomycosis nigrescens usually involves more than one. Coexistence of the two diseases may occasionally have to be considered.

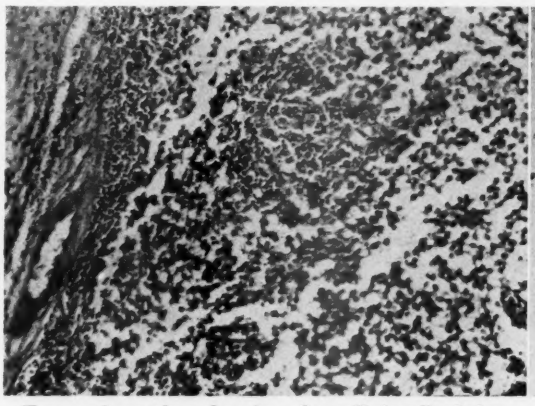

Fig. 3. A section showing the cell detail of the involved inguinal gland.

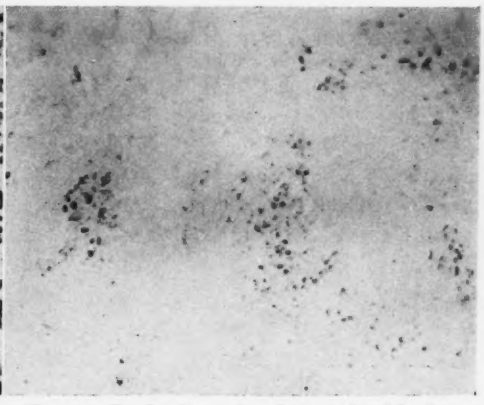

Fig. 4. Becker's stain shows the blackened pigment inside the cells.

All photomicrographs are taken at an approximate magnification of 75 diameters.

TREATMENT

Pack and Adair state, "All reported cases of subungual melanoma have been treated by surgical intervention. Malignant melanomas of all locations are notoriously radio-resistant and those located in the nail bed are doubly so because of their situation."

Amputation should be considered an emergency. Because of the high incidence of metastatic implants in apparently innocent regional glands, the routine removal of these glands has been recommended. Lymph-node dissection follows in one to two weeks when there is gross evidence of metastasis, and in six weeks if the dissection is considered prophylactic.

PROGNOSIS

The prognosis depends upon the metastasis to regional lymph-nodes. The percentage of cures for subungual melanoma is higher than for melanoma of any other location due to the slow rate of growth, the late period of dissemination and the location at the the terminal ends of the phalanges.

Pack[10] has described results of treatment, presumably primarily surgical, in sixteen patients. In ten cases with node involvement there were two five-year survivals free from evidence of recurrence (20 per cent). In the entire group there were four five-year recoveries (25 per cent), one with recurrence. While this is not proposed as representative of the results of surgical treatment of cases generally, fourteen of the patients having had previous treatment elsewhere, it compares with the results obtained in twenty-six cases[10] of melanoma of the hands and feet (not all sugungual) with node involvement treated with radiation alone. There were two living without clinical metastatic melanoma, both less than three years. There were five cases which fulfilled the criteria of five-year cures in an

analogous group of thirty-five patients treated by dissection of the inguinal glands.

CASE REPORT

The patient, a fifty-one year old farmer, first seen in November, 1938, presented a right great toe the medial one-third of which was brownishly pigmented. The involved nail was surrounded by a small swollen inflammatory area. It had been developing over the course of two or three months and the patient stated that it might have been stepped on by stock on two or three occasions. With a tentative diagnosis of paronychia, the involved one-third of the nail and adjacent inflammatory area were excised. The tissue was not examined.

After apparent recovery he was seen again in July, 1939, at which time he stated that two months previously he had noted enlargement in the right inguinal region and progressive pigmentation of the remaining nail. There was, in addition, some periungual inflammatory reaction. At this time the nail and its matrix were removed at the hospital and through an inadvertency the tissue was not examined by the pathologist. Six weeks later the involved inguinal lymph tissue was removed. It was a fluctuant mass which when opened was found to contain a mushy grayish material. The pathologist's report follows:

"The specimen consists of a mass from the inguinal region measuring 5 by 2½ by 2 cm. The mass apparently consists of a conglomerate mass of nodes which are fused together. The cut surface reveals a soft grayish tissue, the center of which is partially hemorrhagic and filled with a brownish hemo-purulent exudate.

"*Microscopic* sections of the lymph node reveal a thin strip of lymphoid tissue within the capsule of each node. The entire center of each node is formed of masses of cells which in some instances are supported by a very thin fibrous stroma and in other areas seem to lie free in a mucoid-like tissue. These individual cells have large vesicular nuclei and rather large nucleoli. The cytoplasm is not increased in amount, yet in a majority of the cells the nucleus is pushed to one side, giving the cell a signet ring appearance. The cytoplasm of these signet cells, however, is thick and granular instead of being clear. Muci-carmine stains show some redness in the cytoplasm of these cells, but previous experience with this stain makes me doubt whether this alone can be taken as absolute evidence of the presence of mucus. The clear mucus-like substance between the cells and in some of the more broken down areas does not take the Muci-carmine stain very well.

"These cells occasionally contain a dark brown pigment occurring in clumps or fine granules. This pigment is very scarce in amount, but does not react for iron and does blacken with silver nitrate.

"The peculiar appearance of these cells and the presence of melanin would make one think that the tumor is a malignant melanoma. Against this diagnosis is the fact that the tumor cells are small; there are no mitoses present, nor giant cells, and there is still the question of the presence of mucus. If mucus is present, it would seem to me to be the result of a peculiar degenerative change in the cells because these cells do not have the typical appearance of mucus producing cells.

"Against the diagnosis of simple lymphadenitis is first, the absence of any evidence of inflammation as far as polymorphonuclear infiltration is concerned; second, the presence of melanin; and third, this peculiar mucus-like degeneration of the cells.

"Opinion: metastatic melanoepithelioma of the lymph node."

Careful review of the patient's medical history and a careful repetition of the physical examination including the blood Kolmer and Kline, a routine blood count, urinalysis, and *x*-ray of the chest were negative. At this time the patient was apprised of the situation and amputation of the toe with a more radical resection of the regional inguinal lymphatics was recommended. The patient underwent examination elsewhere and *x*-ray treatment was recommended. He was given a course of *x*-ray treatment over the inguinal region and, although there are still a number of palpable nodes along the inner thigh and in the inguinal region, there has been no evidence of further progress or metastasis.

CONCLUSION

Subungual melanoma is a condition which is seldom seen but which should constantly be kept in mind in dealing with diseases of the nail and periungual structures. Early recognition and adequate treat-

ment of the condition provides the best prognosis in this particular type of the highly malignant melanomas.

A case of subungual melanoma is reported, the only one in 18,752 new admissions in a general hospital.

Acknowledgment is made of the pathologist's report by Dr. James E. Kahler who also supplied the photomicrographs.

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. . . all tumors of the bronchi are not benign. Unfortunately for mankind, cancer of the lung is a relatively common disease. In these cases the bronchoscope has afforded the only means of positive diagnosis at the early stage in which cancer can be cured.

From—"The March of Medicine"—New York Academy of Medicine (Columbia University Press).

OSTEOID OSTEOMA OF THE FEMUR

REPORT OF A CASE

SAMUEL KLEINBERG
Attending Orthopedic Surgeon, Hospital for Joint Diseases
NEW YORK, NEW YORK

OSTEOID osteoma, described originally by Dr. Jaffe* of New York, is probably a fairly common lesion. In reviewing my surgical experience I have the impression that I have operated upon and cured probably a dozen or more patients with this pathological condition in various parts of the skeleton, under the diagnosis of sclerosing osteomyelitis or Brodie's abscess, which actually were osteoid osteomas. In each of these cases there was a central rarefied area, usually about the size of a dime, surrounded by a variable zone of sclerotic bone. I always expected to find pus in the porotic area, but seeing only soft or granular tissue, usually sterile on culture, assumed that the area contained infected granulation tissue which had become walled off, and that the inflammatory process had not progressed to the stage of suppuration. Dr. Jaffe's very thorough studies of this subject have convinced him and many others that the lesion under consideration is not inflammatory at all but neoplastic. The case herein described is reported because it is typical of osteoid osteoma for the following reasons: first, as in many similar instances the lesion was considered preoperatively by a number of surgeons as a low grade osteomyelitis; second, the clinical features including the history, the course of the illness, the symptomatology and the roentgenographic findings coincide with those described by Dr. Jaffe as common to this pathological entity; third, the gross morphological changes in the femur revealed at operation are characteristic of this lesion; and fourth, the histopathological examination demonstrated a central nidus of osteoid tissue surrounded by a zone of perifocal sclerosis and a complete absence of any inflammatory tissue.

CASE REPORT

Robert P., twenty-four years old, referred by Dr. Louis Shapiro of Paterson, New Jersey, consulted me on April 12, 1939, for swelling and pain in the right thigh and an inconstant limp. The patient had had the usual diseases of childhood from which he recovered without any residual defects. He is supposed to have had infantile paralysis at ten years of age and some cerebral disease previously, but neither illness has left any recognizable physical impairment. About four years previous the patient noticed an insidious onset of pain in the middle of the right thigh. He recalled no specific trauma. The pain continued and recently became aggravated. A noticeable swelling of the thigh appeared about two years later at which time a biopsy was performed in another city and, although a diagnosis of osteomyelitis was made, no further surgery was undertaken. It was manifestly appreciated that the osteomyelitis was atypical. The pain in the thigh was never intense and did not interfere with his daily routine as a student in college, or later as an instructor in one of our universities. There is no record of the rate of increase of the tumefaction of the thigh.

The physical examination was negative except for the right thigh which presented an enlargement of its middle third with tenderness to pressure over the outer surface at the level of the greatest swelling. The tenderness was present only on deep pressure. The soft tissues of the thigh felt normal, but the femur was distinctly thickened. An *x*-ray film (Fig. 1) showed a marked thickening of the cortex on the outer surface of the femur over an area of about four inches in the vertical diameter and,

* JAFFE, HENRY L. Osteoid-osteoma. A benign osteoblastic tumor composed of osteoid and atypical bone. *Arch Surg.*, 21: 5, 1935.

at its greatest width, two inches in the horizontal diameter. The lesion began a little below the lesser trochanter and extended downward along the shaft. Within this area there was a central rarefaction (Fig. 1 A), irregularly oval, one-half inch long and one-fourth inch wide. The rarefied focus corresponded to the region of greatest tenderness.

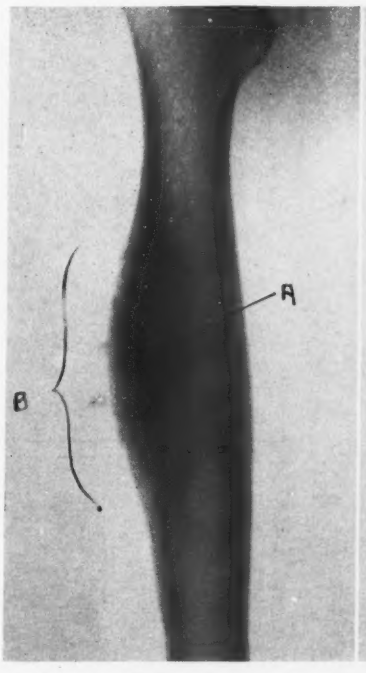

Fig. 1. Roentgenogram of right femur. A, focus of osteoid osteoma; B, area of sclerotic bone enclosing the osteoid osteoma.

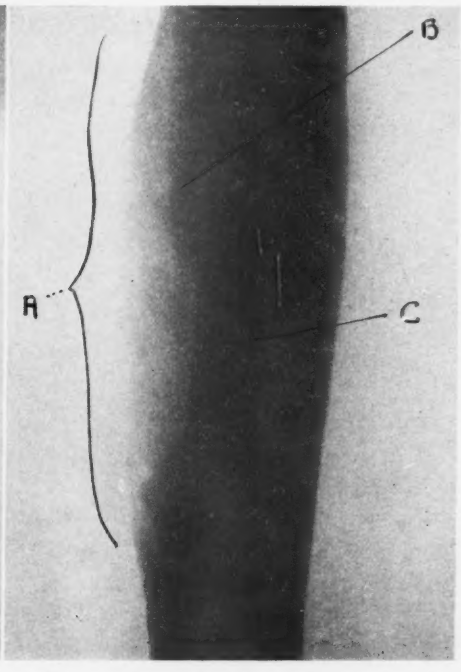

Fig. 2. Postoperative roentgenogram. A, area of operation from which most of the newly formed bone, including the osteoid osteoma, was removed. Note that there is still left a considerable amount of cortical bone, B, where the lesion existed. The medullary cavity, C, is patent and uninterrupted; this is not clear in this reproduction but is evident in the original film.

We were manifestly dealing with a chronic lesion of the femur which was causing pain and disability, and which required and was fortunately susceptible to surgical extirpation. The diagnosis lay between a localized, walled-off infected process, (a Brodie's abscess) and an osteoid osteoma. The ordinary chronic osteomyelitis was out of question for the following reasons: first, because the symptoms were far too mild; second, the lesion was very limited considering the duration of the illness; and third, the *x*-ray films showed none of the changes, such as irregular thickening of the entire width of the shaft with areas of rarefaction and sclerosis, laminae of new bone and sequestra, that are classical for chronic suppurative osteomyelitis.

Accordingly the patient was operated upon June 27, 1939. A six inch vertical incision going directly through the old biopsy scar was made over the outer aspect of the right thigh. The middle of the incision was opposite the most sensitive part of the thigh. The deep fascia and vastus lateralis were incised vertically and retracted, exposing the femur which presented a fusiform swelling over an area of at least three and one-half inches in its vertical diameter. The periosteum was normal in appearance and thickness. It was incised and reflected backward exposing the femur, the surface of which was rough only over the widest part of the enlargement. With a chisel the outer surface of the femur was removed in one mass. This mass was about four inches long, two inches in its anteroposterior diameter and one and one-half inches in its transverse diameter. When this mass was removed, there was found in the middle on its inner surface an excavated area about as big as a dime, filled with soft granular tissue. On the cut surface of the femur was found an area of erosion within the cortex, corresponding to the softened area in the removed mass, in which there was similar

soft granular tissue. A bit of this was taken for a culture. The entire softened area was thoroughly curetted and the tissue saved for pathological examination. No attempt was made to enter the medulla. The bone was made as smooth as possible with chisel and file and the wound was closed in layers without drainage.

The patient made an uneventful and rapid recovery. The pain in the thigh disappeared promptly and has not returned. I have seen him several times since the operation. He has returned to work and considers himself well (October 1939). The culture of the granular tissue removed from the focus in the femur was sterile.

An *x*-ray film (Fig. 2) made about one month after the operation shows that the lesion was completely excised. There is still some thickening of the shaft of the femur. The medullary

FIG. 3.

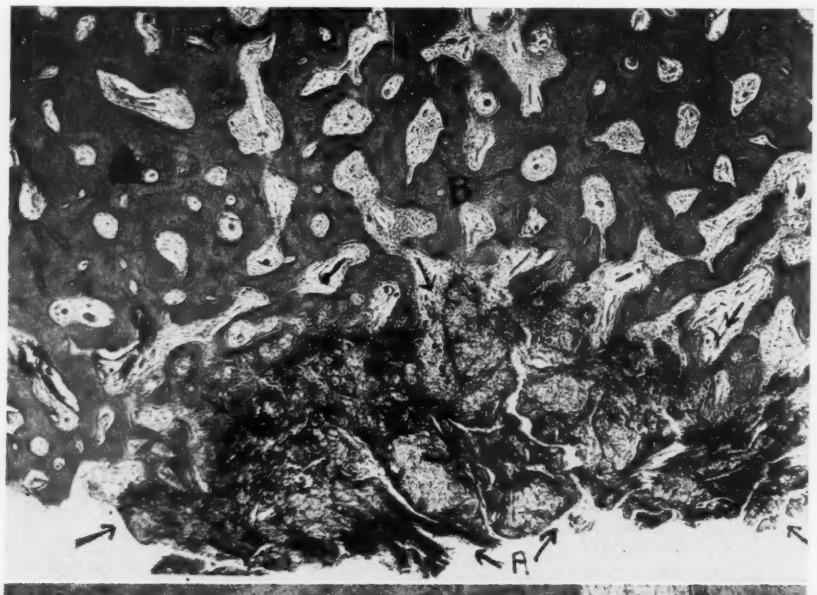

FIG. 4.

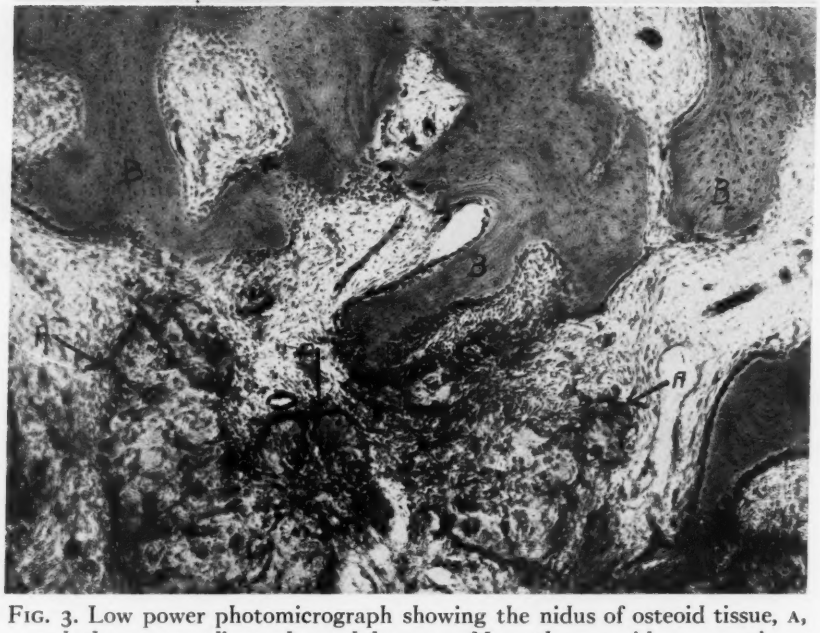

FIG. 3. Low power photomicrograph showing the nidus of osteoid tissue, A, and the surrounding sclerosed bone, B. Note the osteoidosteoma tissue delimited by the arrows. This tissue is clearly of a different histologic nature from the overlying cortical lamellar bone. Detailed examination of the osteoidosteoma showed no evidence of inflammation in or about it.

FIG. 4. Photomicrograph of a higher power than that in Figure 3. Note the calcifying osteoid tissue, A, and the perifocal sclerosed bone, B.

cavity appears undisturbed. According to the roentgenographic film and the findings at operation the focus of disease was entirely within the cortex or at least within cortical bone. The histopathology is well illustrated in the photomicrographs. (Figs. 3 and 4.) Figure 3 is a low power photomicrograph which shows clearly the nidus of osteoid tissue and the surrounding sclerosed bone.

The tissue removed at the operation was examined by Dr. Jaffe who concluded that the lesion was an osteoid osteoma. Formerly, Dr. Jaffe believed that the primary lesion in osteoid osteoma always originated in cancellous bone and then became encased in sclerosed or cortical bone. His more extended experience has convinced him that the osteoid nidus may also arise in cortical bone.* This would seem to be so in the present case in which the focus of disease is entirely within the cortex of the femur.

The detailed histological examination of the tissue removed in this case, as in every other in Dr. Jaffe's experience, did not show any evidence of inflammatory tissue, so that this lesion is definitely not of an inflammatory nature and has nothing in common with such processes as Garré's sclerosing osteomyelitis or Brodie's abscess. Osteoid osteoma is a neoplasm composed of osteoid and atypical bone. It is benign in character because: (1) it is distinctly encapsulated; (2) it is not invasive; (3) it does not recur after excision; and (4) it does not metastasize.

*Jaffe, Henry L. and Lichtenstein, Louis. Osteoid-osteoma. *J. Bone & Joint Surg.*, 22: 645. 1940.

SUMMARY

There is here reported what is considered to be a typical case of osteoid osteoma affecting the right femur. The classical characteristics include the following: The patient was a young adult. The illness appeared insidiously four years ago and progressed slowly. The main subjective complaint was mild but constant pain. The roentgenogram showed a large area of newly formed sclerotic cortical bone within which was a small rarefied focus of osteoid tissue. At operation the osteoid lesion was found to be limited to the cortex, that is, the periosteum was normal and there was no invasion of the surrounding soft tissue or the medullary cavity. The histological picture is typical of the lesion described and considered by Dr. Jaffe as a benign tumor which he has called osteoid osteoma. The patient has been completely relieved by the removal of the diseased area from the femur.

CONVULSIONS ASSOCIATED WITH GENERAL ANESTHESIA: "ETHER CONVULSIONS"

REPORT OF A CASE WITH FINDINGS AT AUTOPSY

STANLEY E. MONROE, M.D.
Clinical Assistant in Surgery, Northwestern University Medical School

AND

EUSTACE L. BENJAMIN, M.D.
Assistant Professor of Pathology, Northwestern University Medical School

EVANSTON, ILL.

CASE REPORT

R. W., a twenty-three year old white man, was admitted to the Evanston Hospital on July 23, 1940, at 6 P.M. On July 21, two days before admission, he was doubled up by a severe pain in his right side. This was followed by severe pains the following day which confined him to bed because the pains were made worse by standing and walking.

Physical examination revealed a well nourished, well developed, muscular young man. The head, chest, neck and extremities were essentially normal. Localized tenderness was present over the lower right abdominal quadrant, most marked over McBurney's point. There was also definite tenderness in the right flank. The mouth temperature was 100°F., the pulse rate 100, the respirations 22. The leucocytes were 17,000 and the erythrocytes were 5,370,000 per cu. mm. Except for two or three leucocytes in each high power field of a centrifuged specimen, urinalysis was normal.

Acute appendicitis was diagnosed. A hypodermic injection of morphine sulfate ¼ grain and atropine sulfate 1/150 grain was given thirty minutes before going to the operating room. Ethylene-oxygen-ether mixture by closed method was administered. His pulse rate was 90; the systolic blood pressure was 120 mm. Hg. The operation began eleven minutes after the anesthetic was started. The patient seemed difficult to anesthetize.

A McBurney muscle splitting incision was made. The appendix was bound down to the cecum by several firm adhesions and there was considerable angulation of the appendix in its middle but it did not seem grossly inflamed. There was no free fluid in the peritoneal cavity. Eighteen or twenty inches of the terminal ileum was normal. The appendix was removed. When the peritoneum was about two-thirds closed, the patient was seized with a series of clonic contractions. In the beginning they were confined to the muscles of the face and neck. They quickly increased in severity to involve the trunk and lower extremities. Within two or three minutes the convulsions made difficult the completion of the operation. The microscopic diagnosis was chronic fibroplastic appendicitis.

At the time of the first convulsion the operation had been in progress sixty minutes and the anesthetic seventy-three minutes, including the time of the induction. The closure of the operative incision was continued and consumed nine minutes, during which time the anesthetic was stopped and intravenous medication started. Calcium gluconate, 10 gr., was given by vein. A few minutes later five more grains was administered. This had no effect on the convulsions. Sodium luminal, 2 gr., was given subcutaneously without apparent effect. About fifteen minutes after the onset of the convulsions the rectal temperature was 105°F. In spite of tepid sponging it rose to 107°F. The patient was placed in an ice pack; an ice water enema was given. About one hour after the onset, the severity of the convulsions had slightly decreased. They ceased after the intravenous administration of 3.75 gr. of sodium amytal. The rectal temperature was 102°F. The patient was given intravenous saline solution (3.25 Gm. per liter). One and seven-eighths grains of sodium amytal was given to control recurring convulsions. Three hours after the onset of convulsions the systolic blood pressure fell to 60 mm. Hg. The lower extremities were wrapped and elevated. Two cc. of coramine and intravenous fluids elevated the systolic blood pressure within the next fifteen minutes to 118 mm. Hg. His pulse rate varied from 140 to 160; the respiration rate varied from 30 to 50. Perspiration was practically

absent at the height of, and subsequent to, the attack. The urinalysis on the first postoperative day revealed the presence of albumin (four plus) and a few erythrocytes. The blood count revealed 15 Gm. of hemoglobin (92.4 per cent); 5,270,000 erythrocytes; and 22,500 leucocytes per cu. mm. The differential blood count was: polymorphonuclear leucocytes 83; staff forms 10; lymphocytes 6; monocytes 1. Biochemic results were: nonprotein nitrogen 33.3; chlorides 485; calcium 8.97; carbon dioxide combining power 45. On the third postoperative day the nonprotein nitrogen was 42.84; glucose 90; chlorides 491; carbon dioxide combining power 48. The report of the spinal fluid examination was Ross-Jones trace; Pandy positive; glucose 82. The fluid was clear and not under increased pressure. Supportive treatment consisted of intravenous fluids and adrenal cortex extract. Sodium bicarbonate and lactate Ringer's solution were given to combat acidosis. Recurring convulsions were treated with sodium amytal. He had involuntary bowel movements. Catheterization was necessary.

Twenty hours after the convulsions the patient was seen by Dr. Lowell D. Snorf. His opinion was: "The heat regulation center has been disturbed either by hemorrhage, embolism, or edema." Encephalitis was also considered.

A neurological examination was made by Dr. Harry Paskind thirty-six hours after the onset of convulsions. The patient was in profound stupor. There was no response to pin pricks. The ankle jerks were present and about equal. The knee jerks were present and fairly brisk. The left arm jerks were brisk. (The right arm was not examined because fluids were being administered in the cephalic vein.) No pathologic reflexes were present. The cremasteric and abdominal reflexes were absent. No facial assymetry was present. The patient did not respond to external stimuli.

The patient died on the seventh postoperative day.

Necropsy was performed four hours after death. The male body was well developed and well nourished. The body length was 170 cm.; the weight, 75 kilos. Rigor and livor mortis were present. The conjunctivae and sclerae were normal. The round right pupil was 5 mm. and the round left pupil was 4 mm. in diameter. Oral hygiene was excellent. The recently shaven, flat abdomen was two fingers' breadth below the level of the symmetrical chest. A recent, healing, sutured McBurney incision, 8 cm. long, was present. Peripheral edema was absent. The vermiform appendix was absent. Its inverted stump was well healed. One hundred fifty milliliters of fibrin-flecked, amber fluid was in the left and 50 ml. of a blood-tinged fluid was in the right pleural cavity. The right heart border was 5.5 cm. and the left heart border was 12 cm. from the midsternal line. The cardiac apex was located in the left sixth intercostal space in the anterior axillary line. The smooth pericardial sac contained 50 ml. of a clear, amber fluid. The right cardiac chambers were dilated.

The thymus was grossly replaced by fat tissue, although microscopic examination of fat tissue taken from the region of the thymus gland revealed a few atrophic lobules of thymic tissue containing degenerated Hassall's corpuscles, separated by, and surrounded with, adult fat tissue.

The thyroid gland weighed 16 Gm. The small lobes were connected by a narrow isthmus. The acini were composed of small and medium-sized follicles lined with cuboidal to flat epithelium. A moderate amount of homogeneous eosinophilic colloid was present. Slight interstitial fibrosis was noted.

The heart weighed 395 Gm. The epicardium was normal. The right chambers were engorged with clotted blood. The left ventricle was 17 mm. and the right ventricle, 4 mm. thick. The circumference of the valve rings were: aortic, 55 mm.; pulmonic, 75 mm.; mitral, 100 mm.; tricuspid, 140 mm. The valvular and mural endocardium was intact. The firm, brown-red myocardium was free from gross scars. The coronary vessels were normal Microscopically the myocardium exhibited slight change. Interstitial edema, slight round cell infiltration and engorgement were present.

The aorta displayed the normal elasticity. Grossly its intima was smooth and the wall thin. No changes were noted in its major branches. The circumference of the aorta was as follows: Directly above the diaphragm, 40 mm. at the celiac axis, 37 mm. A slightly swollen intima, beneath which were narrow, scattered, irregular areas of slightly myxomatous degeneration, were seen in microscopic sections.

The right lung weighed 1,240 Gm. Gross and microscopic examination revealed a moderate fibrinous pleuritis, confluent bronchopneumonia, conjestion and edema.

The left lung weighed 910 Gm. This lung was more severely affected. There was a heavy fibrinous pleuritis. In addition to the congestion, edema and acute confluent bronchopneumonia, there was an unresolved pneumonia which in some areas was beginning to undergo organization. The terminal branches of the pulmonary artery in the upper lobe were thrombosed. A hemorrhagic infarct, 4.5 by 4 by 4 cm., was in the base of the upper lobe. It was undergoing central liquefaction necrosis. Subpleural petechiae were present in both lungs.

The mediastinal and abdominal lymph-nodes were succulent and revealed acute hyperplasia Littoral cells, macrophages and polymorphs were in the sinusoids. Moderate hyperplasia was found in the abdominal nodes. The liver and gallbladder weighed 2,035 Gm. The hepatic sinusoids were moderately engorged. The gallbladder and biliary passages were normal.

The spleen weighed 160 Gm. and was in a state of engorgement and hyperplasia. The normal pancreas weighed 100 Gm.

The right suprarenal gland weighed 10 Gm. and the left, 9 Gm. Except for diminished lipid content of their cortices and engorgement, they revealed no significant changes.

The right kidney weighed 240 Gm. and the left, 220 Gm. Except for considerable engorgement and slight parenchymatous degeneration, they were essentially normal. The excretory renal passages, the urinary bladder, siminal vesicles and prostate were normal.

The gastrointestinal tract exhibited moderate venous engorgement. The visceral venous system was engorged.

The osseous system, as far as could be seen, was grossly normal. The calvarium was normal.

The brain weighed 1,410 Gm. The cerebral and cerebellar hemispheres were symmetrical, uniformly firm, and enclosed in smooth, glistening leptomeninges. There was slight flattening of the cortical convolutions and the sulci were shallow. The vascular system was normal. Microscopic examination revealed the following: In some places a mild diffuse hemorrhage, undergoing early organization was seen in the pia-arachnoid. The small veins of the corpus callosum had swollen endothelial cells and were surrounded by a slight erythrocytic extravasation. Some of the blood had laked. A few macrophages containing hemosiderin were present but leucocytes were absent.

The essential anatomic diagnosis was: Bilateral confluent bronchopneumonia; unresolved pneumonia with beginning carnification; necrotic hemorrhagic infarct of the left upper pulmonary lobe; pulmonary thrombosis; dilatation of the right heart; mild diffuse hemorrhages of the pia-arachnoid; edema and perivascular hemorrhages of the brain; hypoplasia of the aorta; involution of the thymus; atrophy of the thyroid; hyperplasia of the mediastinal and abdominal lymph-nodes; status post appendectomy; healing McBurney's incision.

Dr. Arthur Weil, Associate Professor of Neuropathology at Northwestern University Medical School, re-examined the microscopic sections of the brain. The severe generalized ganglion-cell degeneration found as a result of heat stroke or hyperthermia was not observed.

Because of the possible influence of heat as a cause of the patient's convulsions, one should note that the temperature during the entire day of the operation was very high; the official temperature of the outside air as given by the Chicago weather bureau was 92°F. at 9 P.M., which was approximately the time that the operation started. Because of accumulated heat it is entirely possible that the temperature in the operating room was several degrees higher than that of the outside air.

A large number of case reports on the subject of convulsions associated with general anesthesia have appeared in the literature since 1925. Prior to that time only one author reported upon this subject.

Dr. John S. Lundy[1] published in 1937 a series of 137 cases of convulsions associated with general anesthesia reported as "ether convulsions." In his series the mortality was 18.9 per cent. Doctor Lundy writes: "The type of muscular seizure that is not of short duration may or may not be dangerous. The etiology may not be known, but in any event it seems to me that the important factors are: 1) Convulsions can probably be controlled by the use of barbiturates intravenously. 2) The most dangerous cases are those in which there is profound toxemia and, therefore, in select-

ing the anesthetic for such cases it might be better to use spinal, infiltration, or block anesthesia or avertin to produce basal anesthesia, than to use an inhalation anesthetic only."

Nearly as many theories of the etiology of convulsions under anesthesia have been presented as there are authors writing on the subject. Many suggested causative agents cover a wide and often fanciful range.

In discussing the effect of anoxia on the central nervous system and convulsions during anesthesia, Beecher[2] in the "Physiology of Anesthesia" states; "Damage of the central nervous system by asphyxia is swift and devastating. Its effect here takes precedence over organic damage in other regions of the body. For many years the effects of anoxemia and ischemia on the central nervous system have been studied intensively, beginning with the experimental work of Astley Cooper, 1836."

Gildea and Cobb,[3] in 1930, reviewed the literature on the subject. In an extensive experimental study on cats they have determined the effects of ischemia on the cerebral cortex. "Acute cerebral anemia was produced by largely obstructing the blood flow to the cerebrum for 10 minutes. The mucous membranes of the mouth and nose immediately became pale. The animal stiffens out, then becomes limp and the reflexes usually disappear. At the same time the pulse rate increases and respiration lapses, then becomes irregular and gasping and finally ceases. At the end of from one to two minutes with cessation of respiration, the heart slows down, only to become rapid again for two to four minutes, later, as the vagus center fails, the arteries of the retina decrease in diameter. As the blood flow slows down, one can make out the red blood cells passing through the smaller vessels (we have never observed the blood flow to cease entirely except in animals in which the heart had stopped). Thus, he soon becomes an animal that is completely relaxed, usually with all reflexes absent (occasionally there is an exception) dilated pupils, no tear secretions, depressed furrowed cornea and pallid mucous membranes in the nose and mouth. The heart is slow and the pulse is usually weak in spite of adequate artificial respiration. If the anemia is severe and sufficiently prolonged, convulsions usually appear (in 65 cats out of 90) during this period of observation. This may be preceded by clonic movements of one foot or by rigidity of the whole body. Then there is a brief period of tetanic convulsions which is likely followed by gross clonic convulsions, often involving the whole body. The first seizure may be mild and last only a few seconds, but if cerebral circulation is not restored at once, others quickly follow and they become so violent that it is often impossible to keep the cannula which maintains artificial respiration in the trachea. The usual outcome of such severe convulsions is death."

Beecher[2] states, "Experienced anesthetists who have had the misfortune to witness 'Ether Convulsions' will recognize that Gildea and Cobb have given unintentionally a remarkable description of this catastrophe, and possibly the explanation of its cause as well."

SUMMARY

1. A fatal case of convulsions associated with general anesthesia is reported. One hundred sixty-eight cases have previously been published.

2. The etiology of convulsions under general anesthesia is not established and the treatment is not standardized. The recommendations made by Lundy in 1937 are of interest. They are: "1. Convulsions can probably be controlled by the use of barbiturates intravenously. 2. The most dangerous cases are those in which there is profound toxemia and therefore in selecting the anesthetic for such cases it might be better to use spinal, infiltration, or block anesthesia or avertin to produce basal anesthesia, than to use an inhalation anesthetic only."

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In the rare cases where congestive heart failure does appear for the first time or recurs following delivery, there is some severe complication to produce it.

From—"The Heart in Pregnancy and the Childbearing Age"—by Burton E. Hamilton and K. Jefferson Thomson (Little, Brown and Co.).

PRIMARY ADENOCARCINOMA OF THE JEJUNUM

REPORT OF A CASE

NELSON W. CORNELL, M.D. AND LOUIS A. HAUSER, M.D.
Associate Attending Surgeon, New York Hospital Associate Attending Physician, New York Hospital
NEW YORK, NEW YORK

PRIMARY adenocarcinoma of the jejunum, from study of clinical and postmortem reports in the literature, is a rare condition difficult to diagnose early, associated with a rather high operative mortality and grave prognosis.

FIG. 1. Gastrointestinal film taken January 5, 1939, showing a defect in the jejunum, where the carcinoma was found, with a greatly dilated loop of bowel.

Mayo and Nettrout[1] from the Mayo Clinic, prior to February 1, 1936, reported thirty-one cases of primary adenocarcinoma of the jejunum, or 0.15 per cent of all their carcinomas of the gastrointestinal tract. Twenty of their patients were men and eleven were women, with an average age of fifty-one years. In one-third of their cases, there was a history of carcinoma among some blood relative of present or preceding generation. The chief symptoms were colic, anemia, loss of weight, weakness with fatigueability, intermittent periods of obstruction with vomiting, hematemesis and melena. Gastric analysis on twenty cases showed one case of hyperchlorhydria, while the remainder showed an absence or marked lowering of

gastric hydrochloric acid. The average length of life in their series was 17.6 months, although some patients lived as

FIG. 2. Photograph of gross specimen, with marker indicating point of perforation of the carcinoma.

long as seven years. They also found that *x*-ray studies did not help in making an early diagnosis.

Christofferson and Jacobs[2] reported a case with perforation of the carcinoma with operation and death. Cave[3] reported three cases, which were the only reports entered in the laboratory files of Roosevelt Hospital over a period of sixty-four years.

Carter[4] likewise reported three cases, with one patient alive and well for over a year. The same author quotes Hellstrom as giving a mortality of 43.5 per cent and a cure in only 16 per cent. Carter also states that 72 per cent of primary adenocarcinoma occurs in the first twelve inches of the jejunum. Jones and Harris[5] have reported a case.

Mayo and Nettrout, from all available sources, estimate that over 200 cases have been reported in the literature.

The present case to be reported is the only one in the laboratory files of the New York Hospital since 1932, out of 21,340 specimens examined by Dr. N. Chandler Foot, the Surgical Pathologist.

CASE REPORT

S. B. S., a white male, age thirty-seven years, had an appendectomy at four years of age and repair of incisional hernia twenty-one years later. His father died of carcinoma of the stomach and a sister died at the age of forty-one of malignant abdominal tumor.

On October 20, 1937, the patient had four or five tarry stools and fainted. Later he vomited dark red blood. Examination six days later showed his weight to be 188 pounds; blood count showed a secondary anemia, with hemoglobin of 60 per cent; red blood cells, 3,300,000; white blood cells, 9,100. Gastric analysis showed 110 cc. free HCl 50; total acid 60. There was no occult blood at this time.

X-ray examination by Dr. Louis A. Hauser two weeks later showed a negative stomach and duodenum. The patient was placed on an ulcer regimen and did well until five months later, when he vomited a large amount of greenish, liquid material. His weight at this time was 193 pounds. Eight months after onset, there was marked abdominal distress, with bloating and gas, worse when lying down. Thirteen months after onset, the patient developed what was diagnosed at another hospital as pneumonia. He was given sulfapyridine in large doses, with recovery from the pneumonia. This was followed by recurrent nausea and vomiting. Anemia was more pronounced at this time, with a hemoglobin of 48 per cent; red blood cells, 3,000,000. A blood transfusion was given. His weight was 188 pounds. A gastric analysis at this time showed free HCl of 76; total acid 98. No occult blood was found.

The physical examination showed a mass below and to the left of the umbilicus. *X*-ray examination by Dr. Hauser showed a partial obstruction of the jejunum, about eight inches below the duodenum, with narrowing, a filling defect and a diverticular pocket. There was dilatation of the intestinal loop above the obstruction and narrowing of the intestine below that point.

The patient seemed to be in good condition and was admitted to the New York Hospital.

At this time, his blood count showed 61 per cent hemoglobin; 4,000,000 red blood cells, and 9,900 white blood cells, with a normal differential. Blood serology was negative.

The pathological report by Dr. N. Chandler Foot stated: "The specimen represents a segment that appears to be from the jejunum, approximately 40 cm. in length. The proximal portion is dark red in color, measures about 22 cm., the distal portion about 18 cm., and of normal color. At the junction of these, there is a double ridge of stony-hard tissue, which surrounds the gut with a most extraordinary double ruff, between the lips of which there is a deep cleft, almost as though it had been ploughed out, measuring 1.5 cm. in depth and 1 cm. in width. Completely surrounding the gut like a garter on the outside, there is a scar corresponding to this area and entirely infiltrated by tumor tissue, which is stony-hard. At the point where the double ruff impinges on the mesenteric border of the open gut, the gutter between the two ridges communicates through an opening with a diverticulum or an abscess cavity, approximately 4 cm. in diameter, which is covered by fatty mesentery and

Fig. 3. Photograph of slide showing tumor just beneath the serosa; enlarged about 50 diameters.

An exploratory laparotomy was performed on February 11, 1939, fifteen months after the acute onset of his symptoms.

Under preliminary avertin and ethylene gas anesthesia, the abdomen was opened through a five inch upper left rectus paramedian incision. A large, hard mass, approximately three inches in diameter, was found encircling the jejunum at a distance of six to eight inches from the duodenojejunal junction. There were enlarged regional mesenteric nodes, but no evidence of metastases to the liver or other organs. Approximately eighteen inches of the jejunum was resected, together with all visible and palpable nodes, down to the root of the mesentery. An end-to-end anastamosis was done, with aseptic technic. The mesentery was repaired by interrupted sutures.

apparently lined by continuation of the tumor tissue. This has been opened, so that its contents have been evacuated; presumably, it contained necrotic tissue and blood. In the mesentery, there are several enlarged nodes, most of them quite close to the gut. These nodes show no tumor infiltration, are large, soft and pale angry red.

"Microscopic examination reveals an unusual type of carcinoma of the small bowel. The metaplastic epithelial cells are scattered throughout, forming an adenomatous type of growth. The acini are smaller, but otherwise similar to those found in rectal carcinoma. The malignant cells are very infiltrating and are penetrating in all parts of the section. The penetrating epithelial cells are in the form of very small acini. The mucosa of the small bowel is replaced by slough.

"Pathological Diagnosis: Adenocarcinoma of the Jejunum."

Postoperative Course. A Wangensteen suction apparatus was attached to a tube, passed through the patient's nose into the stomach, and was left in place for five days. The patient was placed on a postoperative intestinal resection regimen, with adequate intravenous glucose therapy and increasing amounts of liquids by mouth after the first twenty-four hours. There was no vomiting and an entirely uneventful recovery resulted. He was allowed up on the twelfth day and home on the fourteenth postoperative day.

Follow-up. On May 9, 1939; three months after operation, *x*-ray examination showed a negative stomach, duodenum and jejunum. On October 10, 1939, eight months postoperatively, *x*-ray examination was still negative. At the present writing, now twenty-five months postoperatively, the patient is still symptom free, with a normal blood count. His present weight is 191 pounds.

SUMMARY

1. Primary adenocarcinoma of the jejunum is rare, and makes up approximately 0.15 per cent of all gastrointestinal carcinoma.

2. Early diagnosis is difficult, but the condition should be suspected in obscure gastrointestinal cases showing colic, anemia, loss of weight, weakness, intermittent obstruction with vomiting, hematemesis and melena, and in which no definite lesion can be demonstrated by *x*-ray in other parts of the gastrointestinal tract.

3. Operative mortality is high and ultimate prognosis poor.

4. A case is reported which was carefully observed and *x*-rayed, and which did not come to operation until fifteen months after onset of symptoms. Resection was performed, followed by an uneventful recovery, and without any evidence of recurrence at the end of a twenty-five month period.

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CASE OF AN OMENTAL CYST IN A THREE WEEKS' OLD FEMALE, CAUSING FATAL ILEUS*

E. J. EICHWALD, M.D.
DAYTON, OHIO

THE youngest case of an omental cyst in Horgan's review[1] is that of Schremm (1903). He reported multiple lymphogenous omental cysts in a one year old female. The youngest cases of solitary lymphogenous cysts are those of Arzela (1922), and of Lawrence (1925). Both patients were three years old.

According to Horgan, symptoms in omental cysts are caused by "pressure, torsion, traction," and he lists them as "nausea, vomiting, . . . anorexia, constipation, or diarrhea, . . . pain, dysuria, frequent micturition."

Montgomery and Wolman,[2] who review fifty-three cases, list the symptoms as: (1) Due to the size of the tumor, and causing diffuse or localized swelling, and abdominal distress; (2) produced by twisting of pedicle, or rupture of cyst, and simulating appendicitis, or the twisting of the pedicle of an ovarian cyst; (3) there are, incidentally, omental cysts which have been found without symptoms.

As far as we know, there is only one report of an omental cyst causing ileus. Shimizu[3] reports the case of a dermoid cyst of the omentum in a forty-five year old male which had been cured. The tumor was the size of a hen's egg and was adherent to the lower part of the parietal peritoneum by a band, causing ileus, and necessitating resection of the gangrenous part of the ileum.

The latest available paper about omental cysts is that of Guernsey,[4] who reviews fifteen cases. Here the theory of postinflammatory pathogenesis is favored, while Montgomery and Wolman believe in the neoplastic hypothesis.

We can report the case of a solitary, probably lymphogenous cyst in a three weeks old female, causing fatal ileus:

CASE REPORT

O. C, female, white, three weeks old, was admitted on July 26, 1940, to St. Elizabeth

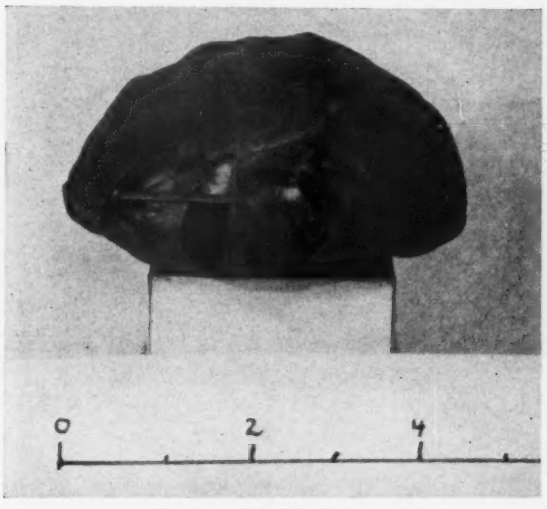

FIG. 1. Omental cyst.

Hospital, Dayton, Ohio. She had no bowel movements for five days; previously they were "not exactly normal." Three hours after the last bowel movement the child vomited. Repeated enemas resulted in small amounts of black, bloody and slimy stool. From that time on she vomited everything. On admission she was comatous, cyanotic, had a severely distended abdomen, and a purplish rash on the lower half of the body. She vomited once after admission and died two hours later.

The temperature on admission was 103.6 degrees; her respiration was 30 per minute. The red blood count was 4.2 millions, the hemoglobin 80 per cent. The white blood count was 8,000, with a differential count of 30 neutrophilic cells, 20 of them unsegmented, and 70 lymphocytes.

An autopsy was performed four hours after death. The body was well developed, fairly

* From the Pathological Department, St. Elizabeth Hospital, Dayton, Ohio.

well nourished and showed a diffuse macular skin eruption. Fat layer and musculature showed only little dehydration. The chest presented no abnormal findings.

cyanotic discoloration. The loops of the last part of the jejunum were edematous, green, opaque, friable and not distended for a length of about three inches. The neighboring part of

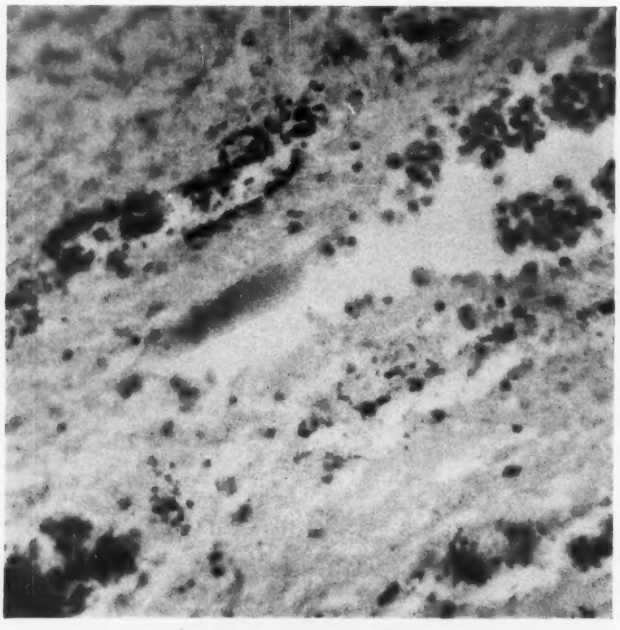

Fig. 2. Cyst wall.

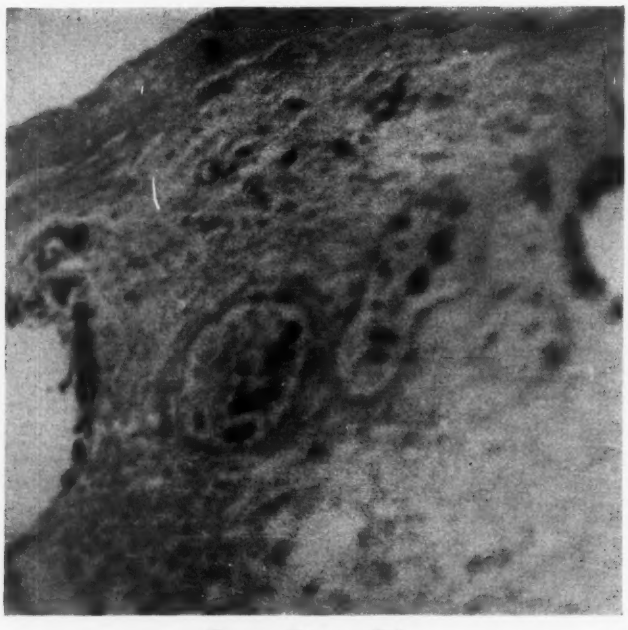

Fig. 3. Cyst pedicle.

On opening the peritoneal cavity, dark brown, foul smelling fluid exuded The parietal peritoneum was covered with fibrinous exudate Stomach, duodenum and the first part of the jejunum were distended. The middle part of the jejunum was also distended and showed

the ileum was cyanotic; appendix, cecum and colon presented no abnormal findings. The mesenterium of the gangrenous part of the bowel showed discoloration and a marked enlargement of the lymphnodes.

The left upper quadrant of the abdominal

cavity was occupied by an ovoid, fluctuating, thin-walled, greenish brown, smooth cyst, measuring 4 by 5 cm. in diameter. (Fig. 1.)

It was attached to the left border of the omentum by a pedicle, the cut surface of which showed soft, gray tissue, honeycombed with minute cysts. The content of the cyst was turbid, dark red, thin fluid. The wall was friable, and was composed of two layers: an outer greenish, firm layer, distinctly separated from the inner layer, which was softer, and absent in many places. It could be separated in thin, friable, lamellary structures. The inner surface of the cyst was reddish brown and finely wrinkled. The cyst pressed on the mesenteric pedicle, interfering with the intestinal blood supply.

The microscopic report stated that the cyst wall was composed of loose, fibrous tissue, without epithelial lining; there were occasional accumulations of round cells. Nearby were similarly shaped, degenerative structures. (Fig. 2.) The section through the pedicle showed a similar structure and contained numerous round and elliptical spaces, mostly empty; some were filled with calcareous material. (Fig. 3.) Occasionally they communicated with the surface. There were occasional areas in the wall, lined with an even, finely granulated layer, which showed many beaker-like, vacant spaces, suggesting anaplastic cylindrical epithelium.

It is evident that this case does not favor the hypothesis of postinflammatory origin of omental cysts, but rather supports the congenital and/or neoplastic theory.

SUMMARY

A case of a solitary, lymphogenous omental cyst is reported in a three weeks' old female, causing fatal ileus.

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New Instruments

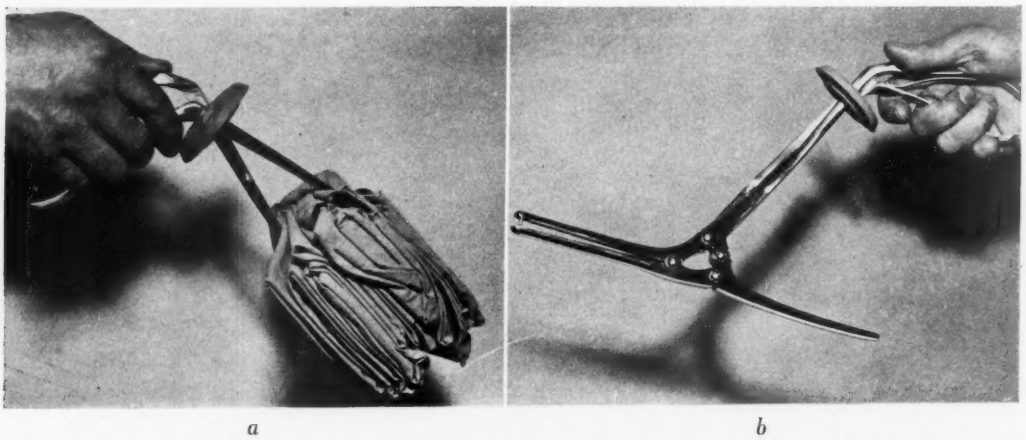
STERILE TRANSFER FORCEPS*

CARL W. WALTER, M.D.
BOSTON, MASSACHUSETTS

THE customary sponge stick or utility forceps have long been recognized as a potential source of contamination of sterile supplies or instruments. Various modifications have been devised to prevent evaporation of the germicide[1] or to provide a sterile lip for the jar,[2] but none has found wide favor, and most hospitals continue to use clumsy, makeshift instruments.

During the past five years, transfer forceps of new design have been developed at the Peter Bent Brigham Hospital. These forceps are unique because their jaws are designed to pick up and grasp firmly any instrument, milliner's needle to heavy retractor, or a sizeable package of dry goods. To safeguard the sterility of the forcep, a germicide jar was devised in which a sterile float escorts the jaws of the forcep beyond the unsterile lip of the jar and makes accidental contamination impossible.

The forcep is forged† from stainless steel.



a *b*

FIG. 1. A new type of transfer forceps permits the controlled transportation of sterile articles of diverse size and shape. Contamination due to the use of awkward instruments is eliminated.

A pistol grip handle, substituted for the finger rings of the conventional sponge stick, provides a stronger, more natural grip and is also advantageous because it projects the jaws of the forcep in the axis of the forearm—a position in which the load can be handled most easily with little chance of contamination due to misdirection of the forceps. A bump near the angle of each handle gives additional purchase for the thumb and forefinger and prevents the handle from slipping back into the palm of a large hand. The jaws are irregularly serrated transversely and have a crescentic

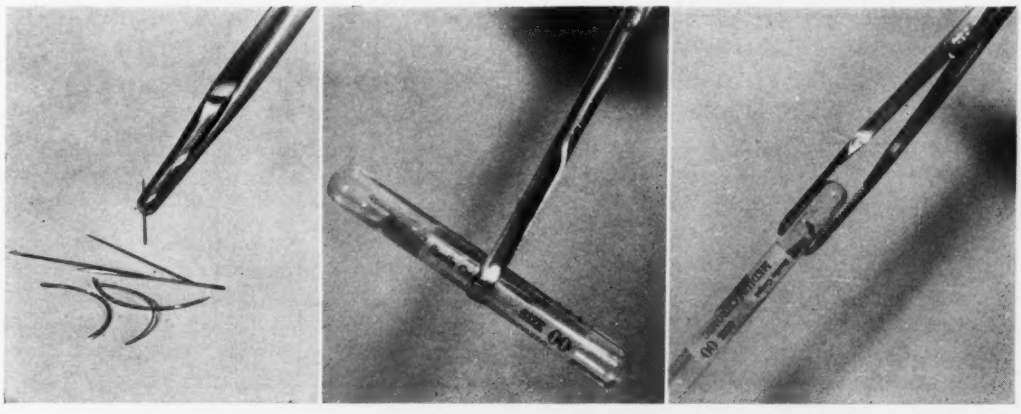
† Bard-Parker Company, Inc., Danbury, Connecticut, manufacturers.

* From the Laboratory for Surgical Research, Harvard Medical School, and the Surgical Clinic of the Peter Bent Brigham Hospital, Boston, Massachusetts.

cross section to afford every opportunity for them to grip cylindrical or irregularly shaped objects.

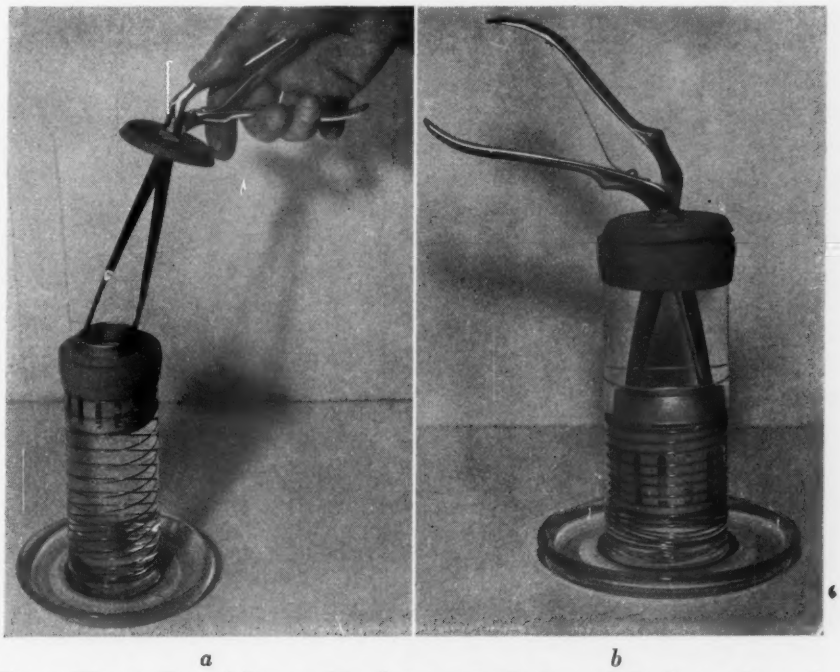
the germicide jar, effectively preventing evaporation of the germicide.

The germicide jar is molded of glass with



a *b* *c*

FIG. 2. The jaws are designed to pick up needles and catgut tubes as well as heavier objects.



a *b*

FIG. 3. The sterile stainless steel bucket escorts the jaws of the forceps beyond the unsterile lip of the germicide jar effectively, avoiding chance contamination. When the forceps are deposited in the jar, the bucket is submerged and the jar is covered to prevent evaporation of the germicide.

The legs of the forceps distal to the lock protrude through a hole in a molded disc-shaped piece of rubber which is snapped over projections of the pivot to position it permanently. The rubber forms a barrier between the handle and the sterile legs and jaws distal to it and serves as a cover for a saucer-like base to lend stability as well as to catch spilled germicide. The jar is graduated so that the germicide[3] can readily be maintained at the proper level. The upper rim of the glass jar is encased in a molded rubber ring, the upper surface of which bears a beveled lip over which the

rubber cover attached to the forceps fits snugly, sealing the jar.

The jar is fitted with a fenestrated, piston-like stainless steel bucket which is held against the rubber encasing the upper edge of the jar by a stainless steel coil spring. The rim of the bucket protrudes 1 cm. above the rubber. When the forceps are put into the jar, their jaws are automatically inserted into the bucket. The weight of the forceps is sufficient to compress the spring and submerge the bucket in the germicide. The germicide is displaced by the bucket as it sinks and flows through the fenestrations. When the forceps are lifted, the sterile bucket guards the sterile jaws against contamination by escorting them beyond the unsterile rim of the jar.

The sterile transfer forceps described are a safe, efficient instrument for the aseptic transportation of sterile articles to the operative field.

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Simply stated, a bronchoscope is a brass tube of a diameter sufficiently small to be inserted through the mouth and larynx into the windpipe, thence on down into the bronchi and lungs. The tissues in front of the tube are rendered visible by suitable electric lighting. Through the tube, accessory instruments can be inserted, such as forceps to grasp a foreign body, suction tubes for removing secretions, and so on.
From—"The March of Medicine"—New York Academy of Medicine (Columbia University Press).

A SYRINGE FOR INJECTING LIPIODOL INTO THE SPINAL CANAL

O. A. NELSON, M.D.
Urologist to Swedish Hospital; Head of a Urological Section, King County Hospital
SEATTLE, WASHINGTON

LIPIODOL used in the spinal canal for a radio-opaque medium has in the past proved difficult to inject through the spinal needle with the ordinary hand syringe. A portion of the opaque medium is frequently lodged outside of the dura, making it impossible at times for the roentgenologist to visualize the actual condition of the spinal canal. Furthermore, spilling of the lipiodol outside of the dura is usually followed by severe pains, whereas a clean injection is painless.

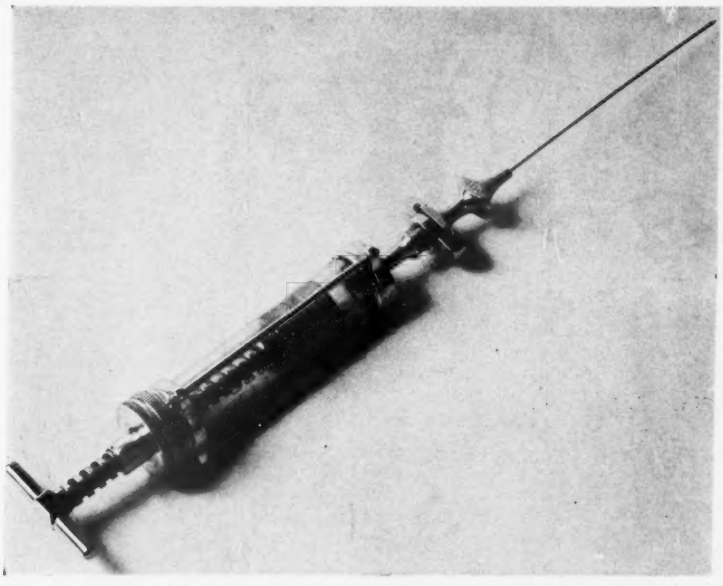

FIG. 1. Worm-drive syringe for injection of lipiodol into the spinal canal.

A worm-drive syringe designed by us and constructed by our mechanic has worked so satisfactorily that we wish to describe its form and operation. It has a metal plunger, the stem of which has a coarse screw thread. The glass barrel has a 10 cc. capacity, with metal attachments at each end. These metal ends are held securely by three truss rods alongside the barrel. The beak of the syringe has an adjustable attachment so that it can be firmly connected to the spinal needle. At the plunger end of the syringe is a metal cap which screws onto the barrel, and in the center of the metal cap is an opening with coarse screw thread to match the screw thread on the stem of the plunger.

After removing the plunger from the barrel, the syringe can be sterilized by boiling. Loading with lipiodol is best accomplished by placing a small hypodermic needle on the beak of the syringe and pouring the lipiodol into the barrel. The plunger is now replaced and excess air expelled. For the purpose of injection the lipiodol need not be warmed but will run more readily from the ampule if placed in alcohol of about body temperature before it is used.

Having prepared the syringe and completed the spinal puncture by a 19 or 20 gauge needle, the operator next attaches the syringe to the spinal needle. Clockwise rotation of the plunger drives the lipiodol through the needle. At the finish, the rotation should be reversed so as to suck the lipiodol from the point of the needle and not leave any of it in the tissue outside of the dura.

TREATMENT OF CEREBRAL ABSCESSES BY TRACTION DRAINAGE*

FREDERIC SCHREIBER, M.D.
Attending Neurological Surgeon, Harper Hospital
DETROIT, MICHIGAN

THE treatment of deep-seated cerebral abscesses is frequently disappointing for a number of reasons. Among these are: the delayed rupture of the abscess contents into a ventricle after drainage has been established, the difficulty of keeping drains in place, incomplete drainage following hour-glass collapse of the abscess wall and damage to the cerebral cortex with fungus formation when an abscess is allowed to extrude itself through the usual trephine opening. In three cases of such deep-seated cerebral abscesses treated recently, a method has been employed which gives promise of overcoming some of the discouraging difficulties which have been encountered.

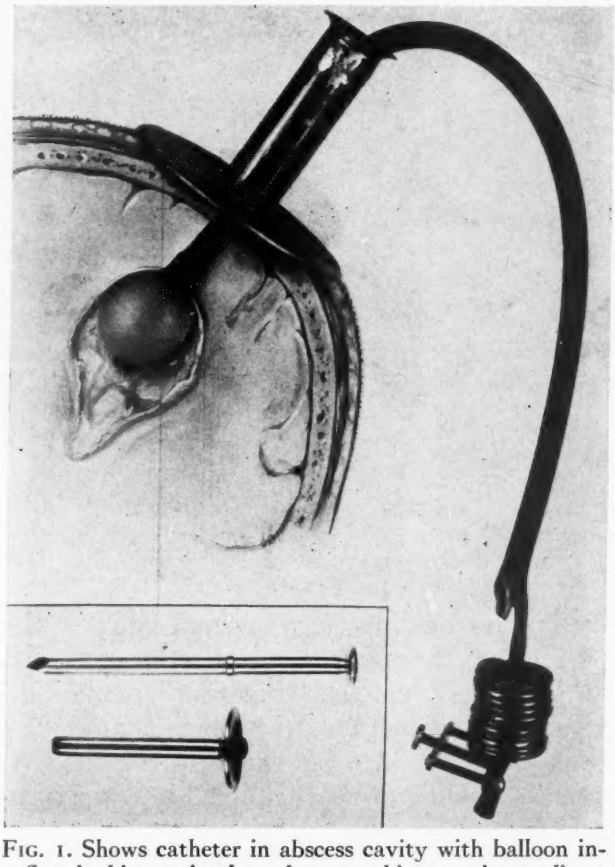

FIG. 1. Shows catheter in abscess cavity with balloon inflated; chimney in place above trephine opening to direct traction; opening in catheter for continuous drainage of pus; metal weights (100 Gm.) above clamp on tube communicating with balloon in abscess cavity. Insert shows trocar and cannula used to introduce catheter into abscess.

In each case the deep abscess was first located by introducing a blunt ventricular needle into the abscess cavity through a

* From the Department of Surgery, Wayne University College of Medicine. Read before Harvey Cushing Society, Kansas City, Missouri, May 3, 1940.

small trephine opening. The size and position of the cavity were more accurately determined after allowing some of the pus to escape and partially filling the cavity with thorotrast or air, and taking roentgenograms. After waiting as long as was thought safely possible, so that the abscess wall would become firmer, a trocar with large cannula was introduced through a nick in the dura into the abscess cavity. The trocar was then withdrawn and a special rubber catheter, which just fitted the cannula, was inserted into the cavity through the cannula. This catheter* had attached to its distal end a small rubber balloon which could be inflated through a separate fine radiopaque tube incorporated in the catheter wall. When the catheter was in place, the balloon was inflated with 15 cc. of air and the tube securely tied to prevent escape of the air. The large lumen of the catheter itself remained patent and allowed pus from the abscess to escape continuously. The metal cannula was then slipped out over the catheter, leaving the catheter securely in place with its balloon inflated inside the abscess cavity.

A metal chimney, three inches high, made from an adhesive tape roller, was then incorporated in a starch head dressing with the chimney directly over the trephine opening and with the catheter threaded through the chimney. A weight of 100 Gm., made up of metal washers, was attached to the free end of the catheter which hung from the chimney, thus insuring a steady traction on the abscess. Pus continued to drain from the catheter and, at the end of a week, the abscess wall in each case had been drawn to the surface of the brain.

The trephine opening was then enlarged in one case, the dura split further and the abscess allowed to extrude itself. In the other two cases the collapsed wall was allowed to remain at the brain surface with residual drainage through the sinus left after the catheter had been removed.

* Traction drainage catheter manufactured by C. R. Bard Company, New York.

SUMMARY

A new method of traction drainage is described for deep cerebral abscesses, employing a special catheter with inflatable balloon attached to its distal end.

Bookshelf Browsing

THE BIBLICAL MYTH OF THE BRAZEN SERPENT

LEO M. ZIMMERMAN, M.D. AND J. A. WEISS, M.D.
CHICAGO, ILLINOIS

THE myth of the brazen serpent, one of the less familiar stories of the Bible, has been the inspiration for this excursion into the byways of medical history as portrayed in classical art. The legend also permits interesting speculation as to its significance in other fields, such as theology and mythology, particularly in regard to the ancient practice of serpent worship.

FIG. 1. Legend of the brazen serpent, Michelangelo (1475–1564). Detail from the Sistine Chapel, Vatican, Rome.

As related in the Book of Numbers, the incident of the brazen serpent occurred during the wanderings of the children of Israel under the leadership of Moses, following the exodus from Egypt after their liberation from bondage. Wearied and discouraged by hardships and privations in the wilderness, the people in despair complained against God and Moses. In punishment, the Lord sent down a plague of fiery, poisonous serpents. The terrified Israelites besought the aid of Moses, whose prayer for assistance for the penitent people was answered:

"And the Lord said unto Moses, make thee a fiery serpent and set it upon a pole: and it shall come to pass, that everyone that is bitten—when he looketh upon it—shall live.

"And Moses made a serpent of brass and put it upon a pole, and it came to pass, that

if a serpent had bitten any man—when he beheld the serpent of brass—he lived."*

This curious story presents three main topics for speculative comment. Its implications may be discussed from the viewpoints of theology, mythology and medical history.

Fig. 2. Legend of the brazen serpent, Tintoretto (1518–1594), Venice.

Primarily one is impressed with the inconsistency of the use of an idol, which is strictly forbidden by the monotheistic tenets of the Hebrew religion as expressed in the first three Commandments:

1. Thou shalt have no other gods before me.

2. Thou shalt not make unto thee any graven image, or any likeness of anything that is in heaven above, or that is in the earth below, or that is in the water under the earth.

3. Thou shalt not bow down thyself to them or serve them.

* Numbers, xxi 8, 9.

The setting up of the brass serpent, therefore, seems to constitute a direct violation of the injunction against graven images. Various interpretations of this story are possible. The sacrilege may in part be refuted, in that the image did not represent an alien god. However, theologians cannot quibble about the fact that even images of Jehovah were forbidden. Another possible explanation involves the concept that the brazen snake was not only a healing device but also a reminder of the grave sin committed by the skeptical Israelites in doubting the Lord, and thus a warning against further transgression. At best, this is but an evasion.

Fig. 3. Legend of the brazen serpent, Van Dyck (1620), Madrid.

The Hebrews, as other early peoples, stood in awe of the demons of the desert. Various diseases and misfortunes were attributed to these malignant demons, which were usually identified with serpents. In this sense the serpent-image could be considered a counterspell and not a representation of the Diety. However, even this interpretation is not entirely acceptable, as it places another power on a level with the Supreme Being, or, at least, it recognizes demonology in conflict with the true monotheistic faith.

It seems incontrovertible, therefore, that the use of the serpent image was an actual variation from the rigid observance of the Mosaic Code. One may surmise that the reason for its intrusion in the early Hebrew mythology was the not uncommon practice for one religion to adopt and modify certain devices or rituals from its predecessors, particularly when long usage had firmly established them in the folklore of the people. This would apply with specific emphasis to serpent-worship which occupied an important, if not dominant, position in most of the primitive religions. As the concept of the Hebrew religion developed to a higher plane of morality the brazen serpent was discarded. This is

evidenced in the action of Hezekiah, one of the later prophets, who instituted many reforms:

"He broke in pieces the brazen serpent that Moses had made, for unto these days the children of Israel did burn incense to it."*

The antiquity of serpent-worship is indicated by the frequent mention of snakes in the religions of ancient peoples.[1] In various mythologies the snake was either a god or a god-symbol. Ishtar, the Babylonian Mother-goddess, was represented as the Earth-Snake. Isis, Egyptian goddess of life and healing, wore a snake headdress. Snakes were revered in Crete, Greece, Phoenicia, India and elsewhere. The dragon was the symbol of the ancient Chinese civilization. The serpent was a character in the Garden of Eden myth. Also, in the Semitic language the stem word for "snake" is the same as that for "life." Snake worship has persisted in modern times in Haitiian voodooism, American Indian ceremonials and in the rituals of many savage tribes throughout the world.

* 2 Kings: xviii, 4.

The fear and reverence of the snake in many instances constituted a cult in which the snake was symbolical of a divine being.[2] This worship was second in importance only to sun-worship. Zwick considers the universality of serpent-worship a reflection of the thoughts of most peoples that the snake possessed a deep mysterious knowledge, symbolized the soul of the universe and was a reincarnation of the Deity.[3]

Fig. 4. Relief on Thirteenth Century Roman Chancellory, Wechselburg, Germany.

The association of the serpent with medicine has been established as very ancient in origin, probably arising simultaneously in various civilizations. Osler, among other authorities, supports this premise: "The idea of the serpent as the emblem of the healing art goes far back into antiquity. The mystical character of the snake, and the natural dread and awe inspired by it, early made it a symbol of supernatural power. From the earliest times the snake has been associated with mystic and magic power, and even today, among native races, it plays a part in the initiation of medicine men." Also, in this connection may be mentioned the caduceus or double-serpent staff, which has some

acceptance through usage as an insignia of the medical profession. Though usually thought of as the emblem of Hermes, the Greek messenger god of commerce, the design can be traced back five thousand years to Ningishzida, the Babylonian god who also had medical attributes.[5,6]

Our particular interest in the legend of the brazen serpent lies in its implication concerning the origin of the accepted insignia of the medical profession, the Aesculapian staff.[7] Aesculapius, the hero-physician of ancient Greece, was deified as the patron of the art of healing about 430 B.C. The staff with the single serpent entwined was then adopted as his attribute. However, as employed in the myth of the Biblical story, the use of the serpent as a symbol of healing antedates this by seven centuries, if one accepts the approximate date of 1200 B.C. as the time of the Exodus of the Israelites from Egypt.

While the Biblical legend of the miraculous healing power of the serpent cannot be claimed as the origin of this symbolism, it affords an early example of the use of the serpent as an insignia of the healing art, preceding its use by the Greeks in connection with Aesculapius, the demigod of medicine. Whether the Greeks adopted the serpent staff from the Biblical story, or as is more probable, from the earlier Babylonian source, must remain an open question.

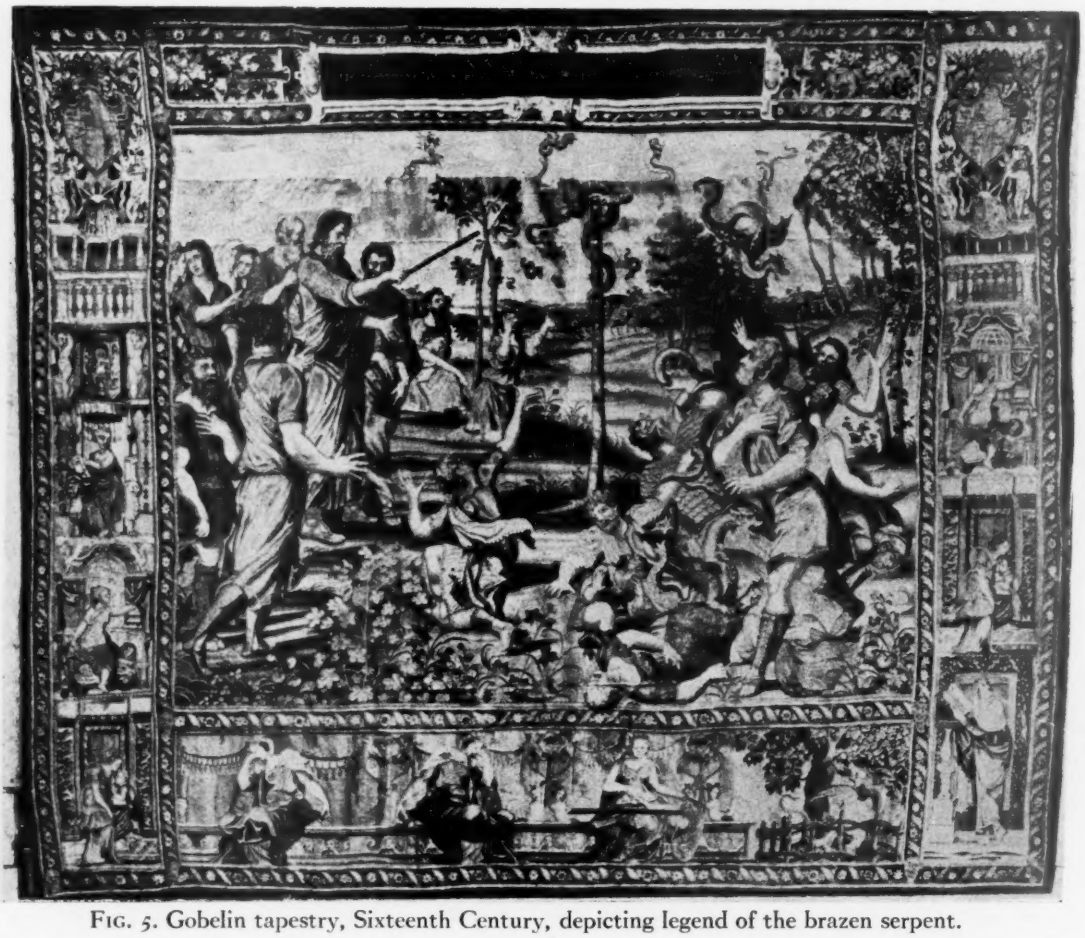

FIG. 5. Gobelin tapestry, Sixteenth Century, depicting legend of the brazen serpent.

The characters and stories of the Bible have been used as the subject of numerous paintings, many of them by famous masters. The Renaissance painters, in particular, favored biblical themes. Hardy has commented: "If the Bible has been the inspiration of countless artists during the last twenty centuries, they in turn have served merely as transmitters of this high inspiration. Each painting not only clarifies

the Bible but reflects the artist's understanding and the culture of his time."[8]

The accompanying illustrations portray the legend of the brazen serpent as conceived by various artists.[9] We were interested in this connection to see how painters depicting the incident would visualize the serpent on the pole. The similarity of their conception to the accepted serpent-entwined staff of Aesculapius is striking.

From the viewpoints of theology, mythology and medical history, this legend has offered a field for various interpretations. Some of these, perhaps, are valid, while others are purely conjectural. Nevertheless, in a small way, it exemplifies how one can find interesting topics for investigation in subjects related to medicine but remote from the clinical or scientific fields. These collateral pursuits help maintain one's enthusiasm, stimulate the inquiring mind and enlarge the appreciation of the cultural and historical background of the profession.

The need for a constant interest in "work by the side of work" is summarized aptly by that revered exponent of the art of medicine, Sir William Osler:

"By the neglect of the studies of the humanities, the profession loses a very precious quality. Man does not live by bread alone. One cannot practice medicine alone and practise it early and late, as so many of us have to do, and hope to escape the malign influences of a routine life. The incessant concentration of thought upon one subject, however interesting, tethers a man's mind in a narrow field. The physician needs a clear head and a kind heart; his work is arduous and complex, requiring the exercise of the very highest faculties of the mind, while constantly appealing to the emotions and finer feelings."

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Selected Book Reviews

THE HEART IN PREGNANCY AND THE CHILDBEARING AGE*

By Burton E. Hamilton, M.D. and K. Jefferson Thomson, M.D.
With a Section Entitled Delivery and Obstetrical After-Care of Cardiacs
By Frederick C. Irving, M.D., F.A.C.S.

THIS excellent book, excellent from all viewpoints, should receive an enthusiastic welcome from the majority of physicians and enjoy a wide distribution. If all doctors of medicine who "take" obstetric cases would read and apply the teachings between the covers of this book, there would be a further lowering of the maternal mortality rate in this country. Also, many women with heart disease who become pregnant and are subjected to therapeutic abortion would be permitted to go to term and have babies. For based on years of observation and clinical experience, the authors' classify the various degrees of cardiac disease and tell us what types should not become pregnant, who should not be permitted to continue with a pregnancy and which ones may safely continue with a pregnancy provided they are handled intelligently.

The basis of this work was started with Dr. Franklin S. Newell who inaugerated and continued a Heart Clinic for ten years. Then Dr. Frederick C. Irving took up the work and enlarged the scope of the study of cardiacs who became pregnant. Covering a period of twenty years this work was done at the Boston Lying-In Hospital. In 1920, Dr. Newell started special services for the study of some of the complications of pregnancy, including heart diseases. At that time (1921) Sir James Mackenzie complained that modern medical knowledge of the heart was, in general, poorly understood and taught. The main object of Mackenzie's work was "to direct the attention of obstetrical physicians to the newer knowledge." He hoped this sub-

*Boston, 1941. Little, Brown and Company.

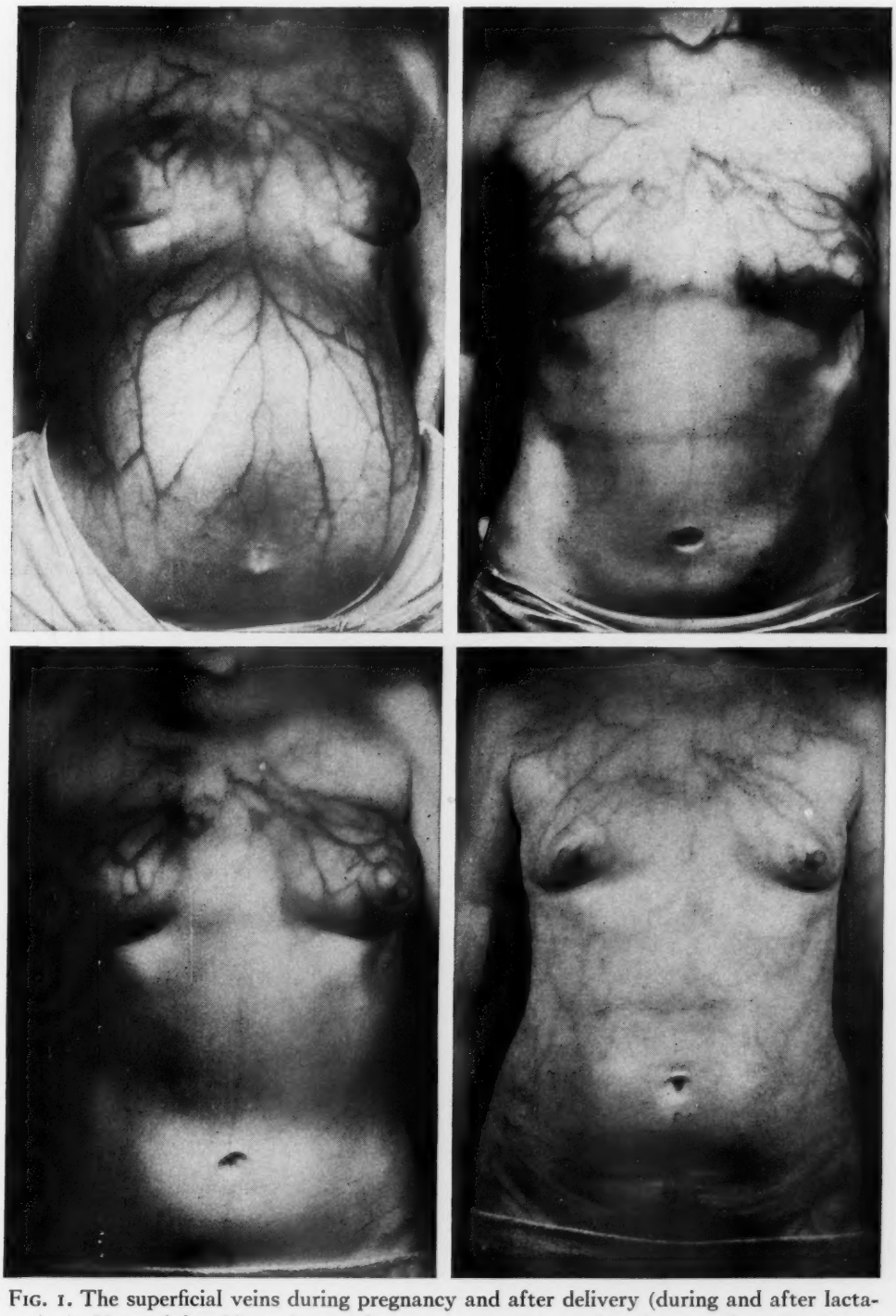

FIG. 1. The superficial veins during pregnancy and after delivery (during and after lactation). Upper left, thirty-nine weeks pregnant; upper right, three weeks postpartum, patient lactating; lower left, eight weeks postpartum, patient lactating; lower right, eight and one-half months after delivery, six weeks after the cessation of lactation. (Fig. 7, in Hamilton and Thomson's The Heart in Pregnancy and the Childbearing Age, Little, Brown & Company.)

ject would be "taken up and pursued by those who have greater facilities than I possess." The Boston Lying-In Hospital offered extraordinary facilities. Rheumatic heart disease is prevalent in Boston. The hook-up of cardiologist and obstetrician was an ideal one. As a result of the work done over these two decades by men of sound scientific attainments in this field we are offered the last word on this subject to date.

We agree with Dr. Hamilton in his Introduction: "The present low maternal mortality of cardiacs can be credited mainly to the rules for their selection and treatment, and nearly all of these many rules are the direct result of out-patient and bedside care, and the study of practitioners of large numbers of women of childbearing age who are cardiacs."

Book I deals with the cardiac in pregnancy. A chapter is devoted to importance, definition, classification, prognosis and treatment, and other chapters deal with treatment of cardiacs in pregnancy, delivery and obstetrical after-care of cardiacs and postpartum complications of cardiacs.

Book II covers physiology of the circulation in normal pregnancy and in pregnant women with cardiac disease.

Book III has eight chapters on heart diseases in pregnancy and the childbearing age. We especially urge one to read the chapters on the heart in preeclampsia, eclampsia and in hypertension and nephritis in pregnant women, rheumatic heart disease in pregnancy and the childbearing age, congenital defects of the heart and great vessels in pregnant women and women surviving puberty, thyroid heart in pregnancy and disorders of the heart beat in pregnancy and in women of childbearing age.

This, briefly, gives one an idea of the scope of this work.

Each author writes well although each has a different style. At no point does the book become dull. It "moves." For those who would delve deeper in the subject a Bibliography is appended at the end of each chapter and there is an ample Index.

Internists, especially those whose field is limited to cardiology, and obstetricians are sure to own a copy of this book, but we sincerely hope large numbers of general practitioners will buy copies and study carefully the printed pages, for they are the men, in the large majority, who do the obstetrics of this country, and on their shoulders will rest the decision of what cardiacs may become pregnant and what ones should be permitted to go to term. The end result is sure to be a lowered maternal mortality rate in those of the childbearing age who suffer from heart disease and become pregnant.

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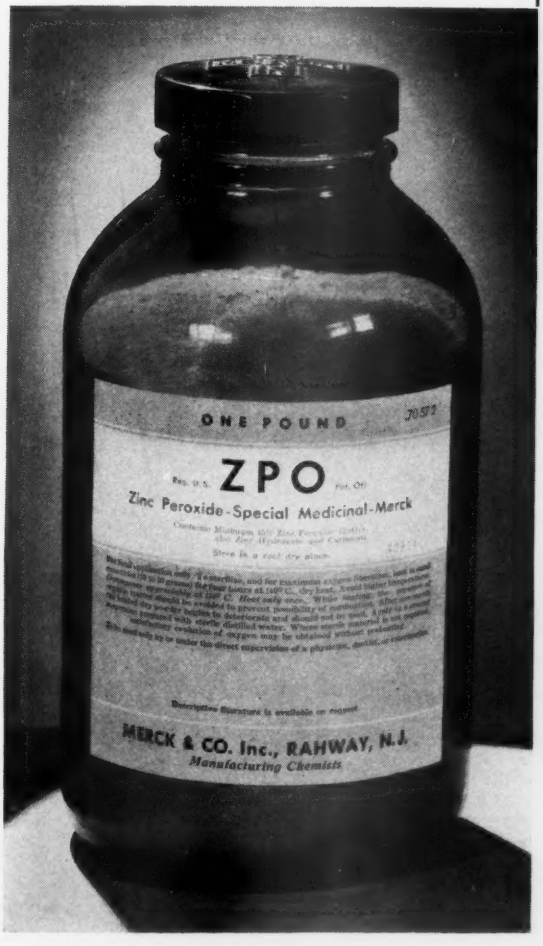

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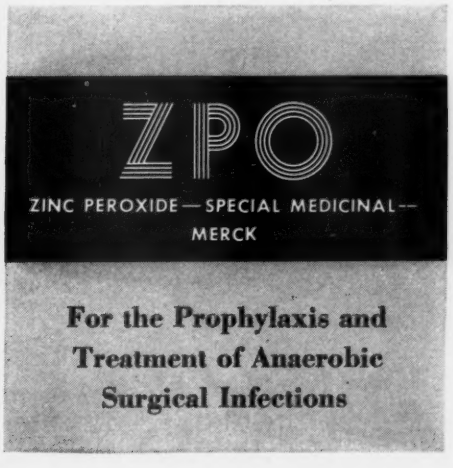

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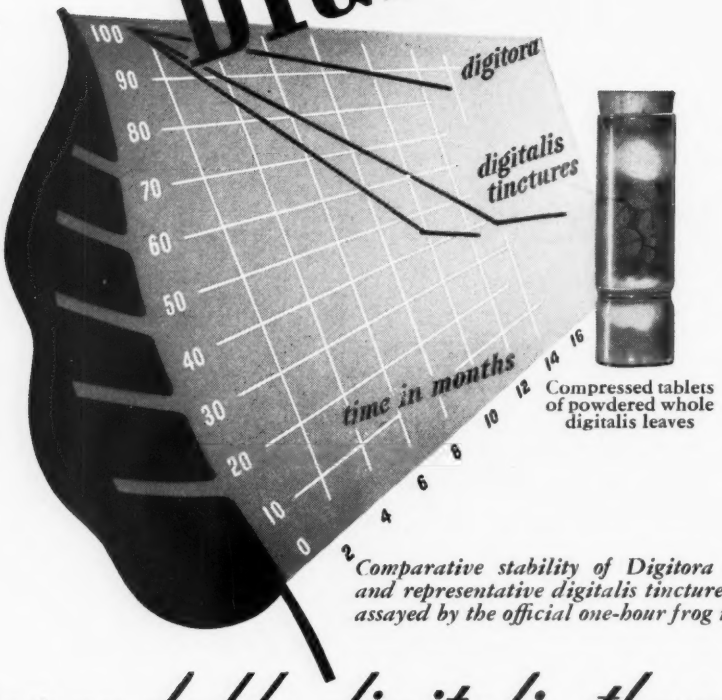

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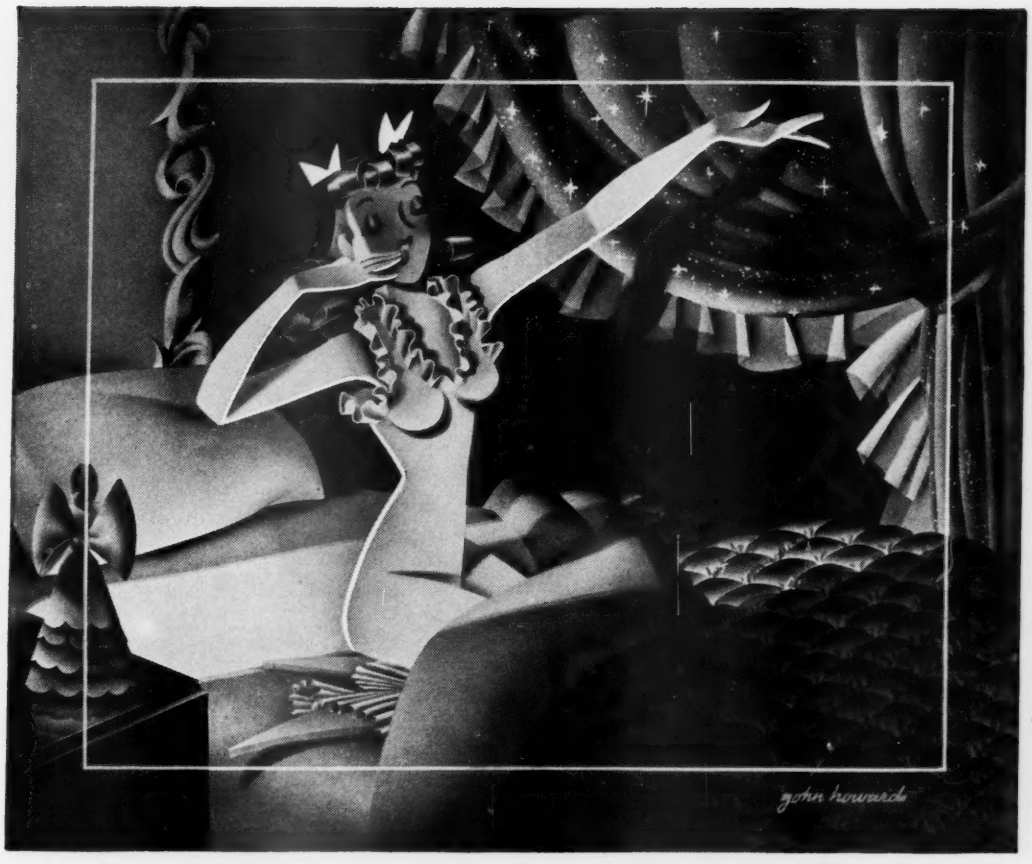

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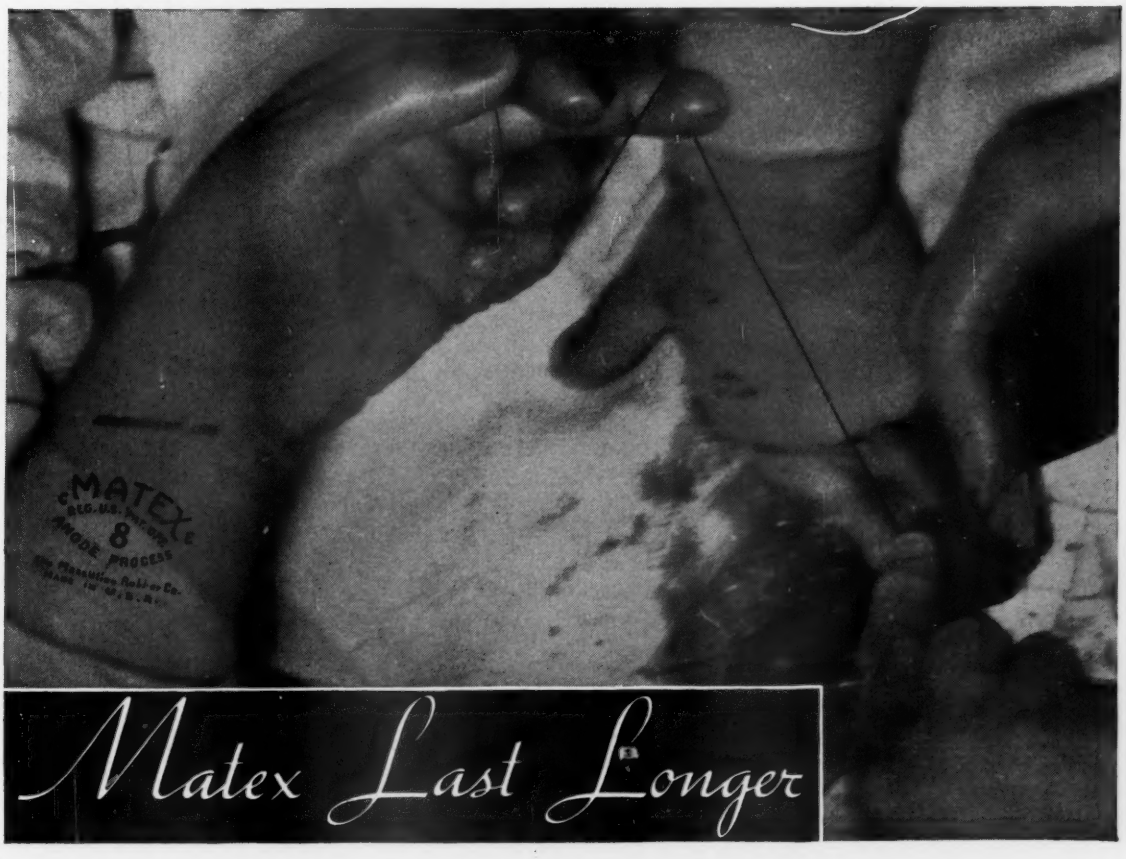

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New Orleans, January 12–16, 1941. (Secretary—DR. CARL BADGLEY, University Hospital, Ann Arbor, Mich.)

AMERICAN ASSOCIATION FOR THE STUDY OF GOITER

Boston, May 12–14, 1941. (Secretary—DR. W. BLAIR MOSSER, Kane, Penna.)

AMERICAN ASSOCIATION FOR THE SURGERY OF TRAUMA

Seigniory Club, Montreal, Que., May 29–31, 1941. (Secretary—DR. RALPH G. CAROTHERS, 409 Broadway, Cincinnati)

AMERICAN ASSOCIATION OF GENITO-URINARY SURGEONS

Hot Springs, Va., May 29–31, 1941. (Secretary—DR. CHARLES C. HIGGINS, 2020 East 93rd Street, Cleveland)

AMERICAN ASSOCIATION OF INDUSTRIAL PHYSICIANS AND SURGEONS

Pittsburgh, May 5–9, 1941. (Secretary—MR. ARMOUR G. PARK, 540 N. Michigan Ave., Chicago)

AMERICAN ASSOCIATION OF OBSTETRICIANS, GYNECOLOGISTS AND ABDOMINAL SURGEONS

Hot Springs, Va., September 11–13, 1941. (Secretary—DR. JAMES R. BLOSS, 418—11th St., Huntington, W. Va.)

AMERICAN ASSOCIATION OF RAILWAY SURGEONS

Chicago, September 8–10, 1941. (Secretary—DR. R. B. KEPNER, 547 W. Jackson Blvd., Chicago)

AMERICAN COLLEGE OF SURGEONS

Boston, November 3–7, 1941. (Secretary—DR. FREDERIC A. BESLEY, 215 N. Sheridan Rd., Waukegan, Ill.)

AMERICAN CONGRESS OF PHYSICAL THERAPY

Washington, D. C., September 1–5, 1941. (Secretary—DR. RICHARD KOVACS, 2 East 88th Street, New York)

AMERICAN GYNECOLOGICAL SOCIETY

Colorado Springs, May 26–28, 1941. (Secretary—DR. RICHARD W. TELINDE, Johns Hopkins Hospital, Baltimore)

AMERICAN MEDICAL ASSOCIATION

Cleveland, June 2–6, 1941. (Secretary—DR. OLIN WEST, 535 N. Dearborn Street, Chicago)

AMERICAN ORTHOPAEDIC ASSOCIATION

Toronto, Can. June 9–12, 1941. (Secretary—DR. C. W. PEABODY, 474 Fisher Bldg., Detroit)

AMERICAN PROCTOLOGIC SOCIETY

Cleveland, June 1–3, 1941. (Secretary—DR. W. H. DANIEL 1930 Wilshire Blvd., Los Angeles)

THE AMERICAN SOCIETY OF ANESTHETISTS, INC.

New York, April 10, 1941. (Secretary—DR. PAUL M. WOOD, 745 Fifth Avenue, New York)

AMERICAN SURGICAL ASSOCIATION

White Sulphur Springs, W. Va., April 28–30, 1941. (Secretary—DR. CHARLES G. MIXTER, 319 Longwood Avenue, Boston)

ASSOCIATION OF MILITARY SURGEONS OF THE U. S.

Louisville, Ky., October 29–November 1, 1941 (Secretary—COL. JAMES M. PHALEN, 1870 Wyoming Ave., N.W., Washington, D. C.)

CONGRESS OF ANESTHETISTS

Boston, November 3–7, 1941. (Secretary—DR. E. KLAUS, 1699 W. 25th Street, Cleveland)

INTERNATIONAL COLLEGE OF SURGEONS

Mexico City, August 10–14, 1941. (Secretary—DR. CHARLES H. ARNOLD, 903–15 Terminal Bldg., Lincoln, Nebr.)

INTER-STATE POST-GRADUATE MEDICAL ASSOCIATION OF NORTH AMERICA

Minneapolis, October 13–17, 1941. (Secretary—DR. TOM B. THROCKMORTON, 406 Sixth Avenue, Des Moines)

NEW ENGLAND SURGICAL SOCIETY

Hanover, N. H., September 5–6, 1941. (Secretary—DR. JOHN F. GILE, Hanover, New Hampshire)

PACIFIC COAST SOCIETY OF OBSTETRICS AND GYNECOLOGY

Pasadena, Cal., November 5–8, 1941. (Secretary—DR. W. B. THOMPSON, 6253 Hollywood Blvd., Los Angeles)

PACIFIC COAST SURGICAL ASSOCIATION

Los Angeles, February 19–22, 1941. (Secretary—DR. H. GLENN BELL, University of California Hospital, San Francisco)

PAN-PACIFIC SURGICAL ASSOCIATION

Honolulu, 1942. (Secretary—DR. FORREST J. PINKERTON, Young Bldg., Honolulu)

SOUTHEASTERN SURGICAL CONGRESS

Richmond, Va., March 10–12, 1941. (Secretary—DR. B. T. BEASLEY, 701 Hurt Bldg., Atlanta)

SOUTHERN SURGICAL ASSOCIATION

Pinehurst, N. C., December 9–11, 1941. (Secretary—DR. ALTON OCHSNER, 1430 Tulane Avenue, New Orleans)

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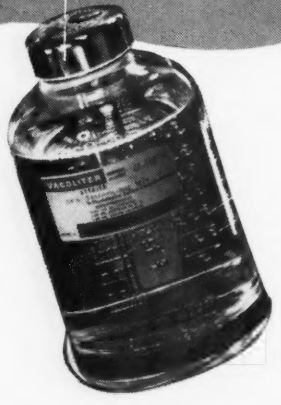

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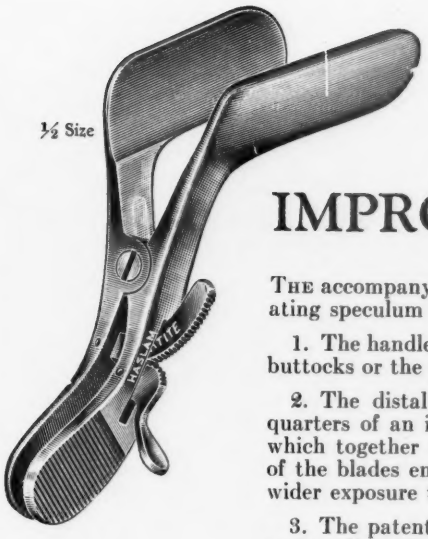

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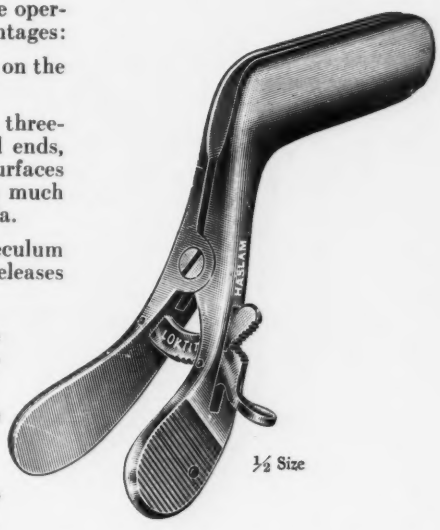

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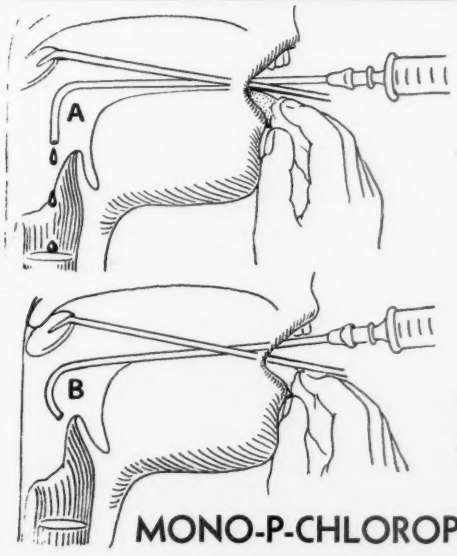

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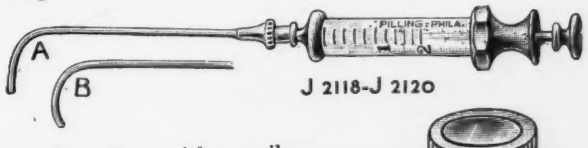

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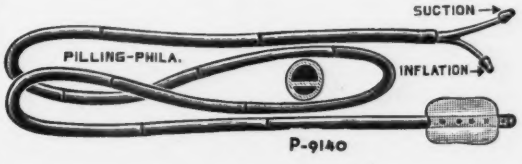

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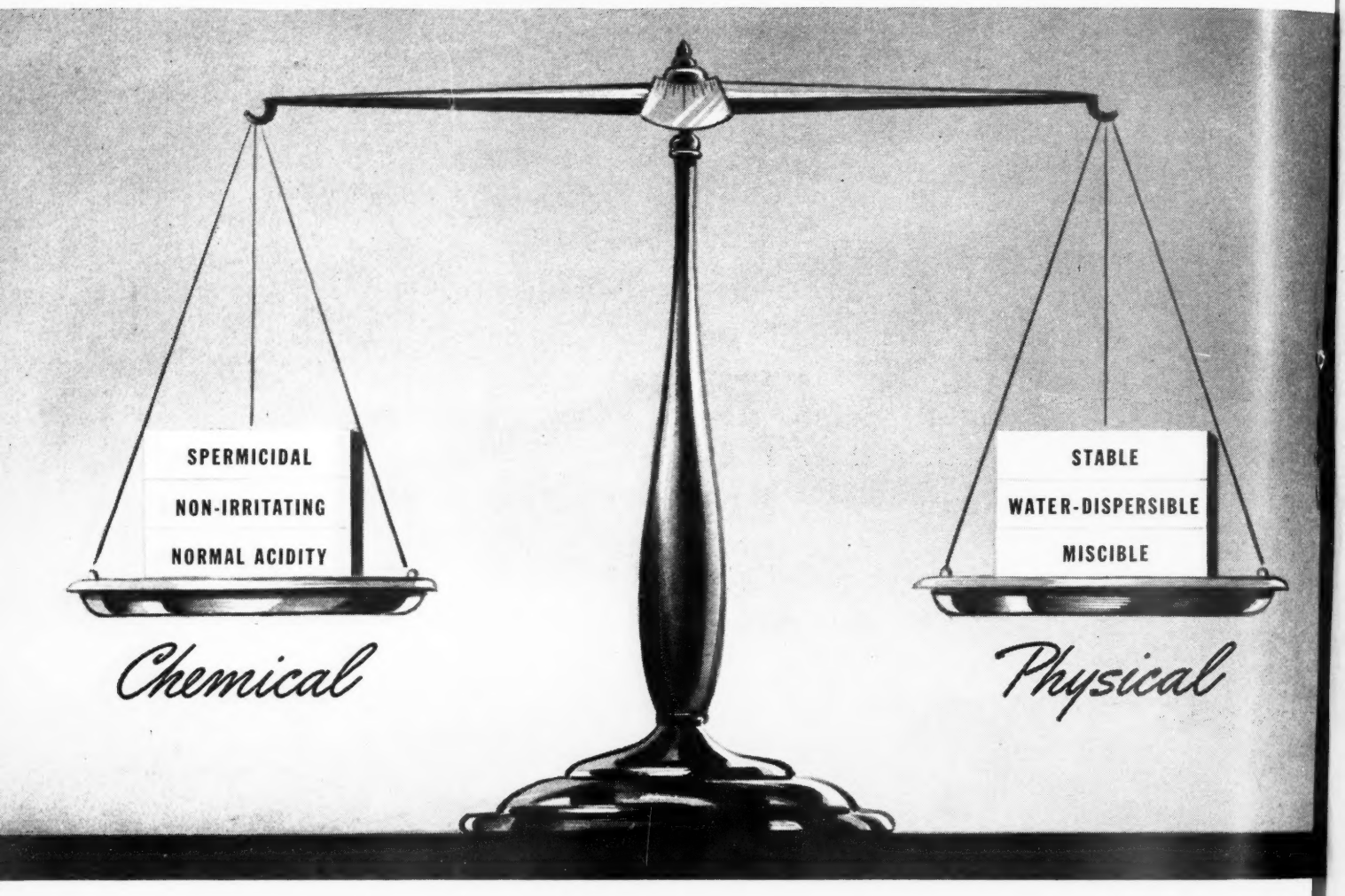

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